

IPU Question Paper 2018

Duration : 3 : 00 Hrs

Exam IPU		Total Questions 150		
Marks for Correct Answer 4	Negative Marks 1	Physics 50	Chemistry 50	Biology 50

Physics

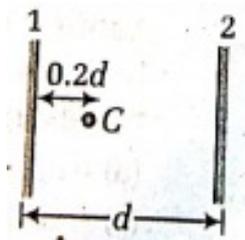
1. Choose the most appropriate option.

Velocity of sound in a gaseous medium is 330 m s^{-1} . If the pressure is increased by 4 times without change in temperature, the velocity of sound in the gas is

- (a) 330 m s^{-1}
- (b) 660 m s^{-1}
- (c) 156 m s^{-1}
- (d) 990 m s^{-1}

Correct: a

2. A gas is enclosed in a metal container with a movable piston on top. Heat is added to the gas by placing a candle flame in contact with the container's bottom. Which of the following is true about the temperature of the gas?



- (a) The temperature must go up, if the piston remains stationary
- (b) The temperature must go up, if the piston is pulled out dramatically
- (c) The temperature must go up no matter what happens to the piston
- (d) The temperature must go down no matter what happens to the piston

Correct: b

3. Choose the most appropriate option.

During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio of $\frac{C_p}{C_v}$ for the gas is

- (a) $3/2$
- (b) $5/3$
- (c) $4/3$
- (d) 2

Correct: a

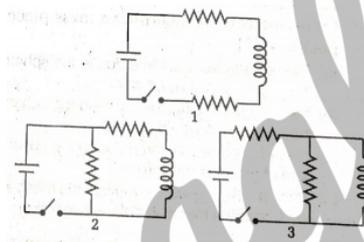
4. Choose the most appropriate option.

A parallel plate capacitor is connected to a battery. A metal sheet of negligible thickness is placed between the plates. The sheet remains parallel to the plates of the capacitor. Which of the following is correct?

- (a) The battery will supply more charge
- (b) The capacitance will increase
- (c) The potential difference between the plates will increase
- (d) Equal and opposite charges will appear on the two faces of the metal plate

Correct: d

5. The diagrams show three circuits with identical batteries, identical inductors, and identical resistors.



Rank them according to the current through the battery just after the switch is closed from least to greatest.

- (a) 3, 2, 1
- (b) 1, 3, 2
- (c) 1, 2, 3
- (d) 3, 1, 2

Correct: b

6. A parallel plate capacitor C has a charge Q. The actual charges on its plates are

- (a) Q, Q
- (b) $Q/2$, $Q/2$
- (c) Q, -Q
- (d) $Q/2$, $-Q/2$

Correct: c

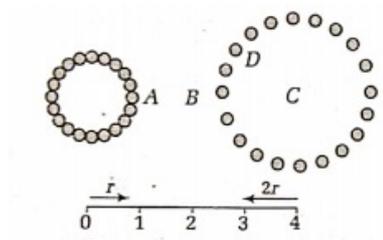
7. Choose the most appropriate option.

A constant voltage is applied between two ends of a uniform metallic wire. Some heat is developed in it. The heat developed is doubled, if

- (a) both the length and radius of the wire are halved
- (b) both the length and radius of the wire are doubled
- (c) the radius of the wire is doubled
- (d) the length of the wire is doubled

Correct: b

8. Use the diagram below to answer the following questions. 40 spheres of equal mass make two rings of 20 spheres each. The ring on the right has a radius twice as large as the ring on the left.



At what position could a mass be placed so that the net gravitational force that it would experience would be zero?

- (a) A
- (b) B
- (c) C
- (d) D

Correct: b

9. Choose the most appropriate option.

In a closed organ pipe, the fundamental frequency is v . What will be the ratio of the frequencies of the next three overtones?

- (a) 2:3:4
- (b) 3:4:5
- (c) 3:7:11
- (d) 3:5:7

Correct: d

10. The Reynolds number for fluid flow in a pipe is independent of

- (a) the viscosity of the fluid
- (b) the velocity of the fluid
- (c) the length of the pipe,
- (d) the diameter of the pipe

Correct: c

11. Choose the most appropriate option.

A metallic ball has spherical cavity at its centre. If the ball is heated, what happens to the cavity?

- (a) Its volume increases
- (b) Its volume decreases
- (c) Its volume remains unchanged
- (d) Its volume may decrease or increase depending upon the nature of heating process

Correct: a

12. Velocity of sound in an open organ pipe is 330 m/s. The frequency of the wave is 1.1 kHz and the length of the tube is 30 cm. To which harmonic does this frequency corresponds.

- (a) 5th
- (b) 4th
- (c) 3rd
- (d) 2nd

Correct: d

13. Choose the most appropriate option.

An electric charge q is placed at the centre of a cube of side l . The electric flux through one of its faces will be

- (a) $\frac{q}{\epsilon_0}$
- (b) $\frac{q}{6\epsilon_0}$
- (c) $\frac{q}{\epsilon_0 l^2}$
- (d) $\frac{q}{4\pi\epsilon_0 l^2}$

Correct: b

14. A cyclotron is operating at a frequency of 12 MHz. Mass and charge of deuteron are 3.3×10^{-27} kg and 1.9×10^{-19} C. To accelerate deuteron the necessary magnetic field is

- (a) 0.16 T
- (b) 1.6 T
- (c) 0.016 T
- (d) 16 T

Correct: b

15. Choose the most appropriate option.

A cylinder rolls up an inclined plane at an angle of 30° . At the bottom of the inclined plane, the centre of mass of the cylinder has speed of 5 m/s. How long will it take to return to the bottom?

- (a) 2 s

- (b) 3 s
- (c) 1.5 s
- (d) 4 s

Correct: b

16. Wave represented by the equation $y_1 = A \cos(kx - \omega t)$ is superimposed on another wave to form a stationary wave such that the point $x=0$ is a node. The equation representing the wave is given by

- (a) $A \cos(kx + \omega t)$
- (b) $-A \cos(kx + \omega t)$
- (c) $A \sin(kx + \omega t)$
- (d) $-A \sin(kx - \omega t)$

Correct: b

17. Choose the most appropriate option.

Two liquid drops of equal radii are falling through air with the terminal velocity v . If these two drops coalesce to form a single drop, its terminal velocity will be

- (a) $\sqrt{2} v$
- (b) $2v$
- (c) $\sqrt[3]{4} v$
- (d) $\sqrt[3]{2} v$

Correct: c

18. Five organ pipes are described below. Which one has the highest frequency fundamental?

- (a) A 2.3 m pipe with one end open and the other closed
- (b) A 3.3 m pipe with one end open and the other closed
- (c) A 1.6 m pipe with both ends open
- (d) A 3.0 m pipe with both ends open

Correct: c

19. Choose the most appropriate option.

A coil in the shape of an equilateral triangle of side l is suspended between two pole pieces of a permanent magnet, such that magnetic field, B is in plane of the coil. If due to a current I in the triangle, a torque τ acts on it, the side l of the triangle is

- (a) $2 \left(\frac{\tau}{\sqrt{3}Bl} \right)^{\frac{1}{2}}$
- (b) $\frac{2}{\sqrt{3}} \left(\frac{\tau}{Bl} \right)$
- (c) $2 \left(\frac{\tau}{Bl} \right)^{\frac{1}{2}}$
- (d) $\frac{1}{\sqrt{3}} \frac{\tau}{Bl}$

Correct: a

20. The engineer of a train blows the train whistle as he approaches a crossing. A few moments later he hears an echo from the whistle. The engineer hears the echo of the whistle because of

- (a) reflection
- (b) refraction
- (c) constructive interference
- (d) destructive interference

Correct: a

21. Choose the most appropriate option.

A Carnot engine takes 3×10^8 cal of heat from a reservoir at 627°C and given it to a sink at 27°C . The work done by the engine is

- (a) 4.2×10^6 J
- (b) 8.4×10^6 J
- (c) 16.8×10^6 J
- (d) 2×10^6 J

Correct: b

22. Photoelectron emission rate is a direct function of radiation

- (a) frequency
- (b) speed
- (c) intensity
- (d) energy

Correct: c

23. Two identical non-conducting spheres having charges of -12 nC and $+8$ nC are touched together and then separated. The final charge on each is

- (a) -2 nC
- (b) $-\left(\frac{2}{3}\right)$ nC
- (c) $+2$ nC
- (d) $+4$ nC

Correct: a

24. Choose the most appropriate option.

The potential energy of gravitational interaction of a point mass m and a thin uniform rod of mass M and length L , if they are located along a straight line at a distance a from each other, is

- (a) $U = \frac{GMm}{a} \ln\left(\frac{a+L}{a}\right)$

$$(b) U = GMm \left(\frac{1}{a} - \frac{1}{a+L} \right)$$

$$(c) U = -\frac{GMm}{a}$$

$$(d) U = -\frac{GMm}{L} \ln \left(\frac{a+L}{a} \right)$$

Correct: d

25. A positive charge enters a magnetic field and travels parallel to but opposite the field. The charge feels or experiences

- (a) an upward force
- (b) a downward force
- (c) an accelerative force
- (d) no force

Correct: d

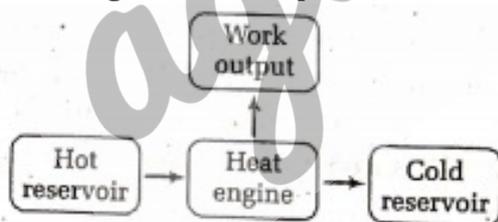
26. Choose the most appropriate option.

A simple harmonic wave of amplitude 8 unit travels along positive x-axis. At any given instant of time, for a particle at a distance of 10 cm from the origin, the displacement is + 6 unit and for a particle at a distance of 25 cm from the origin, the displacement is + 4 unit. Calculate the wavelength.

- (a) 200 cm
- (b) 230 cm
- (c) 210 cm
- (d) 250 cm

Correct: d

27. The diagrammatic representation of a heat engine above shows which of the following?



- (a) Positive work
- (b) An adiabatic process
- (c) An isobaric process
- (d) An isochoric process .

Correct: c

28. A force is applied to an object that is free to move. Which of the following statements is correct?

- (a) The frictional force is larger than the applied force
- (b) The frictional force is smaller than the applied force

- (c) The weight of the object is larger than the applied force
 (d) All of these statements could be correct

Correct: d

29. Choose the most appropriate option.

A rigid bar of mass 15 kg is supported symmetrically by three wires each 2 m long. Those at each end are of copper and the middle one is of iron. Determine the ratio of their diameters if each is to have the tension.

- (a) 12.6 : 2
 (b) 1.31 : 1
 (c) 4.65 : 3
 (d) 2.69 : 4

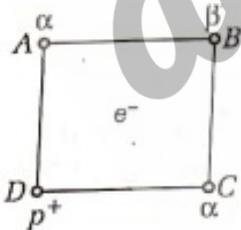
Correct: b

30. An astronaut is standing on an asteroid when he accidentally drops a wrench. He observes that the gravitational acceleration on the asteroid is 2.4 m/s^2 . If he had thrown the wrench at an upward angle instead, he would have found the gravitational acceleration on the asteroid to be

- (a) less than 2.4 m/s^2
 (b) toward him at 2.4 m/s^2
 (c) downward at 2.4 m/s^2
 (d) greater than 2.4 m/s^2

Correct: a

31. The two-dimensional cube in the diagram below has charged objects placed at the corners as shown. An electron that is free to move is placed at the exact centre of the cube. In which direction will the electron move?



- (a) It will move toward A
 (b) It will move toward B
 (c) It will move toward C
 (d) It will move toward D

Correct: d

32. Choose the most appropriate option.

A body takes 5 min for cooling from 50°C to 40°C . Its temperature comes down to 33.33°C in next 5 min. Temperature of the surroundings is

- (a) 15°C
- (b) 20°C
- (c) 18°C
- (d) 17°C

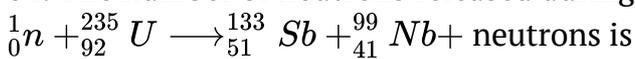
Correct: b

33. A TV tower has a height of 100 m. How much population is covered by TV broadcast, if the average population density around the tower is 1000km^{-2} (radius of Earth = $6.4 \times 10^6\text{m}$)?

- (a) 10^3
- (b) 10^6
- (c) 4×10^6
- (d) 4×10^9

Correct: c

34. The number of neutrons released during the fission reaction



- (a) 1
- (b) 92
- (c) 4
- (d) 3

Correct: c

35. For a monoatomic gas, work done at constant pressure is W. The heat supplied at constant volume for the same rise in temperature of the gas is

- (a) $\frac{W}{2}$
- (b) $\frac{3W}{2}$
- (c) W
- (d) $\frac{5W}{2}$

Correct: d

36. Choose the most appropriate option.

For constructive interference to take place between two monochromatic light waves of wavelength λ , the path difference should be

- (a) $(2n - 1)\frac{\lambda}{4}$
- (b) $(2n + 1)\frac{\lambda}{4}$
- (c) $(2n - 1)\frac{\lambda}{5}$
- (d) $n\lambda$

Correct: d

37. If the work done in stretching a wire by 1 mm is 2 J. the work necessary for stretching another wire of same material but with double radius of cross-section and half the length by 1 mm is
- (a) 16J
 - (b) 8J
 - (c) 1/16 J
 - (d) 1/8 J

Correct: b

38. A particle of mass m executes SHM with amplitude a and frequency ν . The average kinetic energy during its motion from the position of equilibrium to the end is
- (a) $2\pi^2 ma^2\nu^2$
 - (b) $4\pi^2 ma^2\nu^2$
 - (c) $\frac{1}{2}\pi^2 ma^2\nu^2$
 - (d) $\pi^2 ma^2\nu^2$

Correct: d

39. Choose the most appropriate option.

Two identical thin plano-convex glass lenses (refractive index 1.5) each having radius of curvature of 20 cm are placed with their convex surfaces in contact at the center. The intervening space is filled with oil of refractive index 1.7. The focal length of the combination is:

- (a) -20 cm
- (b) -25 cm
- (c) -50 cm
- (d) 50 cm

Correct: c

40. A force $F = (2+x)\text{N}$ acts on a particle in the x -direction. The work done by this force during a displacement from $x = 1.0\text{ m}$ to $x = 2.0\text{ m}$ is

- (a) 2.1 J
- (b) 2.5 J
- (c) 3.5 J
- (d) 4.5 J

Correct: c

41. Choose the most appropriate option.

When a hydrogen atom is raised from the ground state to fifth state

- (a) both KE and PE increase
- (b) both KE and PE decrease
- (c) PE increases and KE decreases
- (d) PE decreases and KE increases

Correct: c

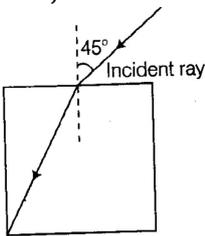
42. A particle moves in one dimension. Its velocity is given by $v(t) = c_2t^2 + c_1t + c_0$ where c_1 and c_2 are constants. What is the acceleration of the particle at time $t = 1$?

- (a) $C_1 + 2c_2$
- (b) zero
- (c) $c_1 + c_2$
- (d) C_1

Correct: a

43. Choose the most appropriate option.

A light ray falls on a square glass slab as shown in the figure. The index of refraction of the glass, if total internal reflection is occur at vertical face, is equal to



- (a) $\frac{(\sqrt{2}+1)}{2}$
- (b) $\sqrt{\frac{5}{2}}$
- (c) $\frac{3}{2}$
- (d) $\sqrt{\frac{3}{2}}$

Correct: d

44. A positive point charge is placed at the origin. There is an electric field $E(x) = 2,2 + 3$ that accelerates the Udda point charge along the x-axis. Determine the energy of the charge when it reaches the position $x = 21$. (a)

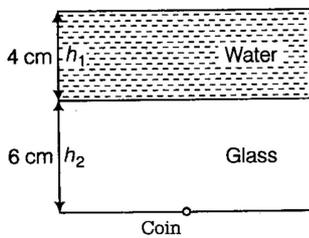
6 qdE.

- (a) $6qdE_0$
- (b) $12q$
- (c) $12qdE_0$
- (d) $24qdE_0$

Correct: c

45. Choose the most appropriate option.

A 4cm thick layer of water covers a 6 cm thick glass slab. A coin is placed at the bottom of the slab and is being observed from the air side along the normal to the surface. Find the apparent position of the coin from



- (a) 7.0 cm
- (b) 8.0 cm
- (c) 10 cm
- (d) 5 cm

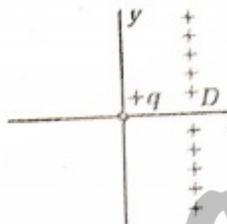
Correct: a

46. A substance's specific heat is a function of its

- (a) mass
- (b) weight
- (c) volume
- (d) molecular structure

Correct: d

47. There is a plane of uniform positive charge density σ parallel to the yz -plane and located at $x = 2d$. A point charge q^+ is placed at the origin. Solve for the position x along the x -axis, where a positive test charge will have a net force of zero.



- (a) $x = \frac{\sqrt{q}}{2\pi\epsilon\sigma}$
- (b) No Solution
- (c) $x = \sqrt{\frac{2\pi\sigma}{d}}$
- (d) $x = -2d$

Correct: a

48. A displacement vector is a

- (a) change in position
- (b) velocity
- (c) scalar
- (d) distance without direction

Correct: a

49. The difference between two audible frequencies is about 4 Hz. If one frequency is 380 Hz

and the speed of sound is 340 m/s, the other frequency might be about

- (a) 300 Hz
- (b) 325 Hz
- (c) 350 Hz
- (d) 375 Hz

Correct: d

50. Choose the most appropriate option.

At high altitude, a body at rest, explodes into two equal fragments with one fragment receiving horizontal velocity of 10 m/s. Time taken by the two radius vectors connecting point of explosion of fragments to make 90° is

- (a) 105
- (b) 45
- (c) 2 s
- (d) 1 s

Correct: c

Chemistry

51. Which of the following best explains, why a hot air balloon rises?

- (a) The heating of the air causes the pressure inside the balloon to increase
- (b) The cool outside air pushes the balloon higher
- (c) The temperature difference between the inside and outside air causes convection currents
- (d) Hot air has a lower density than cold air

Correct: d

52. Choose the most appropriate option.

Which of the following molecules can be described as having sp hybridisation?

- (a) CO_2
- (b) CH_4
- (c) SF_4
- (d) H_2O

Correct: a

53. How many milliliters of water must be added to 50.0 mL of 10.0 M HNO_3 to prepare 4.00 M HNO_3 ?

- (a) 50.0 mL
- (b) 125 ml
- (c) 250 mL

(d) 75.0 mL

Correct: d

54. Choose the most appropriate option.

The energy required to excite the electron in the atom from $n=1$ to $n=2$, when the ionisation enthalpy of hydrogen atom is $1.312 \times 10^6 \text{ J / mol}$ will be (in the unit of 10^5)

- (a) 8.53
- (b) 7.51
- (c) 8.92
- (d) 9.86

Correct: d

55. Beyond the critical point of H_2O

- (a) H_2O exists in a state of equilibrium with all phases
- (b) liquid water can no longer exist
- (c) only the solid phase can exist
- (d) H_2O can no longer exist as a molecule

Correct: d

56. Choose the most appropriate option.

For the isoelectronic series S^{2-} , Cl^- , Ar , K^+ and v , which species requires the least energy to remove an outer electron?

- (a) S^{2-}
- (b) Cl^-
- (c) Ar
- (d) K^+

Correct: a

57. Stomach acid has a pH of approximately 2 Sour milk has a pH of 6. Stomach acid is

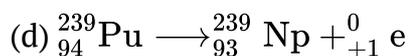
- (a) 3 times as acidic as sour milk
- (b) 4 times as acidic as sour milk
- (c) 100 times as acidic as sour milk
- (d) 10,000 times as acidic as sour milk

Correct: d

58. Choose the most appropriate option.

Which of the following choices represents $\frac{239}{94}\text{Pu}$ producing a position?

- (a) $\frac{239}{94}\text{Pu} \longrightarrow \frac{235}{94}\text{Pu} + \frac{4}{2}\text{He}$
- (b) $\frac{239}{94}\text{Pu} \longrightarrow \frac{0}{-1}e \longrightarrow \frac{239}{93}\text{Np}$
- (c) $\frac{239}{94}\text{Pu} \longrightarrow \frac{0}{-1}e \longrightarrow \frac{239}{94}\text{Np}$



Correct: d

59. What is the conjugate base of H_2CO_3 according to the Bronsted-Lowry theory?

- (a) CO_3^{2-}
- (b) HCO_3^-
- (c) H_3CO_3^+
- (d) CO_2

Correct: b

60. What happens when the temperature of a reaction increases?

- (a) The activation energy increases
- (b) The rate constant increases
- (c) The enthalpy change increases
- (d) The order of the reaction increases

Correct: b

61. Choose the most appropriate option.

What is the minimum power required for heat engine to lift a 80 kg mass 5 m in 20 s if it releases 1000 J of heat energy from its exhaust each second?

- (a) 200 w
- (b) 500 w
- (c) 1200 w
- (d) 3000 w

Correct: c

62. Calculate the mass percent of 60 g H_2SO_4 dissolved in the solution of 180 mL of water.

- (a) 25%
- (b) 33%
- (c) 50%
- (d) 66%

Correct: b

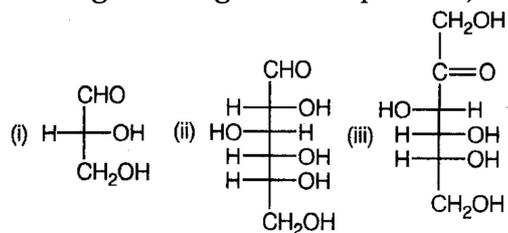
63. Which of the following stereoisomers is a major image of itself?

- (a) Anomer
- (b) Epimer
- (c) Meso compound
- (d) Geometric isomer

Correct: b

64. Choose the most appropriate options.

Among all the given compounds, which will have D-configuration?



(a) 5 and 15

(b) 5 and 16 have D-configuration?

(c) 2 and 16

(c) 2 and 15 CH₂OH

Correct: a

65. All of the following may be true concerning catalysts and the reaction which catalyse except,

(a) catalysts are not used up by the reaction

(b) catalysts lower the energy of activation

(c) catalysts increase the rate of the reverse reaction

(d) catalysts shift the reaction equilibrium to the right

Correct: d

66. Choose the most appropriate option.

NH₃ has a K_b of 1.8×10^{-3} . Which of the following has a 5.6×10^{-10} ?

(a) NH₃

(b) NH₄⁺

(c) NH₂⁻

(d) H⁺

Correct: a

67. When 2.00 g of a certain volatile liquid is heated, the volume of the resulting vapour is 821 mL at a temperature of 127°C at standard pressure. The molecular mass of this substance is

(a) 20.0 g/mol

(b) 40.0 g/mol

(c) 80.0 g/mol

(d) 120. g/mol

Correct: c

68. Choose the most appropriate options.

Among $[\text{Ni}(\text{CN})_4]^{2-}$, $[\text{NiCl}_4]^{2-}$ and $[\text{Ni}(\text{CO})_4]$

(a) $[\text{NiCl}_4]^{2-}$ is square planar and $[\text{Ni}(\text{CN})_4]^{2-}$ $[\text{Ni}(\text{CO})_4]$ are tetrahedral

(b) $[\text{Ni}(\text{CO})_4]$ is square planar and $[\text{Ni}(\text{CN})_4]^{2-}$ $[\text{NiCl}_4]^{2-}$ are tetrahedral

- (c) $\text{Ni}(\text{CN}_4)^{2-}$ is square planar $[\text{NiCl}_4]^{2-}$
 $\text{Ni}(\text{CO})_4$
 (d) None of these

Correct: c

69. Given a molecule with the general formula AB_2 , which one of the following would be the most useful in determining whether the molecule was bent or linear?

- (a) Ionisation energies
 (b) Electron affinities
 (c) Dipole moments
 (d) Electronegativities

Correct: c

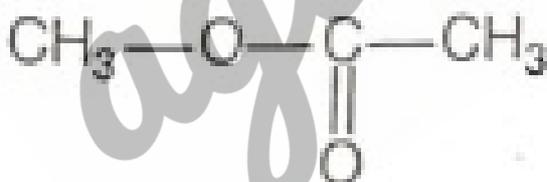
70. Choose the most appropriate option.

Which of the following expressions represents the solubility product for $\text{Cu}(\text{OH})_2$?

- (a) $K_{\text{sp}} = [\text{Cu}^{2+}] [\text{OH}^-]^2$
 (b) $K_{\text{sp}} = [\text{Cu}^{2+}]^2 [\text{OH}^-]$
 (c) $K_{\text{sp}} = [\text{Cu}^{2+}]^2 [\text{OH}^-]^2$
 (d) $K_{\text{sp}} = [\text{Cu}^{2+}] [\text{OH}^-]$

Correct: a

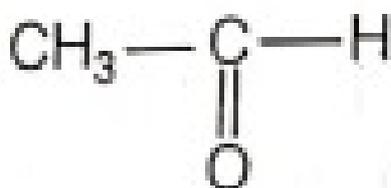
71. Which of the following represents an ester?



- (a)
 (b) $\text{CH}_3 - \text{O} - \text{CH}_3$



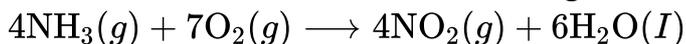
(c)



(d)

Correct: a

72. Ammonia burns in air to form nitrogen dioxide and water.



If 8 moles of NH_3 are reacted with 14 moles of O_2 in a rigid container with an initial pressure of 11 atm. What is the partial pressure of NO_2 in the container when the reaction runs to completion? (Assume constant temperature)

- (a) 4 atm
- (b) 6 atm
- (c) 11 atm
- (d) 12 atm

Correct: a

73. Choose the most appropriate options.

Beryllium gives a compound X with the following percentage composition : Be – 6.1%
N – 37.8%, C1 – 48%, H – 8.1% Molecular weight of X is 148g mol^{-1} and that of Be is 9g mol^{-1} . The molecular formula of the compound is

- (a) $\text{BeN}_4\text{Cl}_2\text{H}_{12}$
- (b) BeN_2ClH_6
- (c) $\text{BeN}_4\text{Cl}_2\text{H}_6$
- (d) BeN_4ClH_8

Correct: a

74. An object experiences a greater buoyant force in seawater than in fresh water. The most likely reason for this is

- (a) seawater has greater osmotic pressure making the pressure difference greater at different depths
- (b) fresh water has greater osmotic pressure making the pressure difference greater at different depths
- (c) seawater has greater density
- (d) fresh water has greater density

Correct: c

75. The reaction below represents the Haber process for the industrial production of ammonia, $\text{N}_2(g) + 3\text{H}_2(g) \sim 2\text{NH}_3(g)$; $\Delta H^{-2} = -92\text{kJ}$

The optimum conditions of temperature and pressure are chosen as a compromise between those that favour a high yield of ammonia and those that favour a fast rate of production.

Economic considerations are also important. Which statement is correct?

- (a) A higher temperature would ensure a higher yield and a faster rate
- (b) A lower pressure would ensure a higher yield at a lower cost
- (c) A lower temperature would ensure a higher yield and a faster rate
- (d) A higher pressure would ensure a higher yield at a higher cost

Correct: d

76. Choose the most appropriate options.

On combustion of x-g of ethanol in bomb calorimeter, y-joules of heat energy is produced.

The heat of combustion of ethanol (ΔH_{comb}) is

- (a) $\Delta H_{\text{comb}} = -x \cdot J$
- (b) $\Delta H_{\text{comb}} = -yJ$
- (c) $\Delta H_{\text{comb}} = -\frac{x}{y} \times 44J\text{mol}^{-1}$
- (d) $\Delta H_{\text{comb}} = -\frac{y}{x} \times 44 J\text{mol}^{-1}$

Correct: d

77. A balloon contains 2.0 g of hydrogen gas. A second balloon contains 4.0 g of helium gas. Both balloons are at the same temperature and pressure. Pick the false statement from the following list.

- (a) The number of hydrogen molecules is the same as the number of helium atoms in each balloon
- (b) The density of the helium in its balloon is greater than the density of the hydrogen in its balloon
- (c) The volume of each balloon is the same
- (d) The average speed of the molecules/atoms in each balloon is the same

Correct: c

78. Choose the most appropriate option.

Ammonia reacts with water to form the ammonium ion and hydroxide ion.



According to the Bronsted-Lowry definition of acids and bases, what is the conjugate acid of ammonia?

- (a) NH_3
- (b) NH_4^+
- (c) OH^-
- (d) H^+

Correct: b

79. Choose the most appropriate options.

The vapour pressure of pure water is 23.5 mm Hg. Then, the vapour pressure of an aqueous solution which contains 5 mass percent of urea is (Molar mass of urea is 60).

- (a) 23 mm Hg
- (b) 18 mm Hg
- (c) 31 mm Hg
- (d) 35 mm Hg

Correct: a

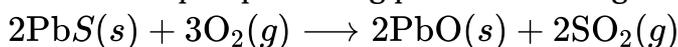
80. Choose the one false statement.

- (a) Nuclei with an even number of protons and an even number of neutrons tend to be stable
- (b) γ -rays are high-energy photons
- (c) Nuclei with too few neutrons per proton tend to undergo positron (0_1e) emission
- (d) Nuclei with too few neutrons per proton tend to undergo β -particle (${}^0_{-1}e$) emission

Correct: c

81. Choose the most appropriate option.

The first step in producing pure lead from galena (PbS) is as follows:



All of the following are true concerning this reaction except

- (a) Both lead and sulphur are oxidised
- (b) Oxygen is the oxidising agent
- (c) Lead sulphide is the reducing agent
- (d) Lead is neither oxidised nor reduced

Correct: a

82. When the following 1.0 mol dm^{-3} aqueous solutions are arranged in order of increasing pH, which is the correct order?

- I. Ammonium chloride
- II. Ammonium ethanoate.
- III. Sodium ethanoate

- (a) I < II < III
- (b) II < I < III
- (c) III < I < II
- (d) III < II < I

Correct: a

83. When the solids $\text{Ba}(\text{OH})_2$ and NH_4SCN are mixed, a solution is produced and the temperature drops.



Which statement about the energetics of this reaction is correct?

- (a) The reaction is endothermic and ΔH is negative
- (b) The reaction is endothermic and ΔH is positive
- (c) The reaction is exothermic and ΔH is negative
- (d) The reaction is exothermic and ΔH is positive

Correct: b

84. Choose the most appropriate options.

Argon crystallises in fcc arrangement and the density of solid and liquid Ar is $1.59\text{g}/\text{cm}^3$ and $1.42\text{g}/\text{cm}^3$, respectively. The percentage of empty space in liquid Ar is

- (a) 34.84%
- (b) 43.8%
- (c) 23.4%
- (d) 21.6%

Correct: a

85. A student wished to produce only carbon from the dioxide and water vapour combustion of methane, CH_4 . To accomplish this the student should

- (a) burn CH_4 in limited oxygen
- (b) burn CH_4 in a vacuum
- (c) burn CH_4 in excess oxygen
- (d) burn CH_4 at a very low temperature

Correct: c

86. Choose the most appropriate option.

Which of the following elements is the most chemically similar to Na?

- (a) H
- (b) Mg
- (c) C
- (d) Cs

Correct: d

87. The rate of the chemical reaction between substance A and B is found to follow the rate law.

$$\text{rate} = k[A]^2[B]$$

where, k is the rate constant The concentration of A is reduced to half of its original value. To make the reaction occur at 50% of its original rate, the concentration of B should be

- (a) decreased by $1/4$
- (b) halved
- (c) kept constant
- (d) doubled

Correct: d

88. Choose the most appropriate options.

When 4A of current is passed through a 1.0L, $0.10\text{MFe}^{3+}(\text{aq})$ solution for 1 h, it is partly reduced to Fe(s) and partly of $\text{Fe}^{2+}(\text{aq})$.

Identify the incorrect statement.

- (a) 0.10 mole of electrons are required to convert all Fe^{3+} to Fe^{2+}

- (b) 0.025 mol of Fe(s) will be deposited
 (c) 0.075 mol of iron remains Fe^{2+}
 (d) 0.050 mol of iron remains as Fe^{2+}

Correct: c

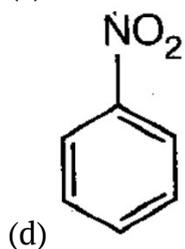
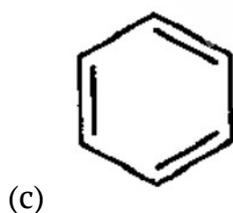
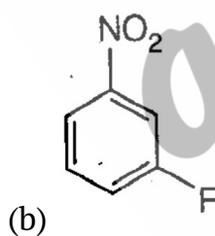
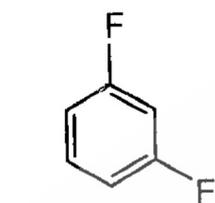
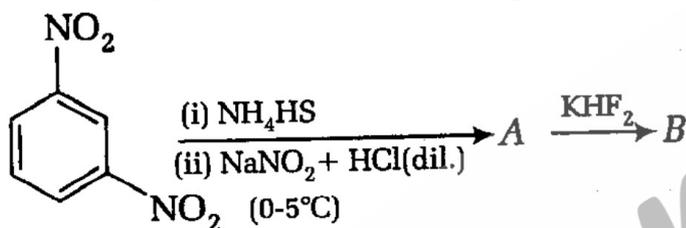
89. Calculate the rate constant for the radioactive disintegration of an isotope that has a half-life of 6930 yr.

- (a) $1.00 \times 10^{-5} \text{yr}^{-1}$
 (b) $1.00 \times 10^{-4} \text{yr}^{-1}$
 (c) $1.00 \times 10^{-3} \text{yr}^{-1}$
 (d) $1.00 \times 10^{-3} \text{yr}^{-1}$

Correct: d

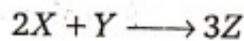
90. Choose the most appropriate options.

Identify the product B of the following reactions



Correct: b

91. The following data was obtained for the reaction,



Experiment	X	Y	Rate (mol L ⁻¹ s ⁻¹)
1.	3.0	1.5	1.8
2.	1.5	3.0	0.45
3.	1.5	1.5	0.45

What is the proper rate expression?

- (a) rate = k [X][Y]
- (b) rate = k[Y]²
- (c) rate = [X]
- (d) rate = k[X]²

Correct: d

92. Which of the following are true statements?

- I. The heat capacity of a substance is the amount of heat that substance can hold per unit of temperature.
- II. The specific heat for a single substance is the same for all phases of that substance.
- III. When heat is added to a fluid, its temperature will change less if it is allowed to expand.

- (a) Only
- (b) Only III
- (c) I and III
- (d) All of these

Correct: c

93. Choose the most appropriate option.

Compared to an electron with a principal quantum number of 1, an electron with a principal quantum number of 2 will have a

- (a) lower energy
- (b) higher energy
- (c) negative spin
- (d) positive spin

Correct: b

94. What is the minimum number of moles of Pb(NO₃) must be added to 0.10L of a solution that is 1.0M in MgCl₂ and 1.0 M in KCl? The compound PbCl₂ precipitates.

- (a) 1.0 mol
- (b) 0.20 mol
- (c) 0.50 mol

(d) 0.15 mol

Correct: d

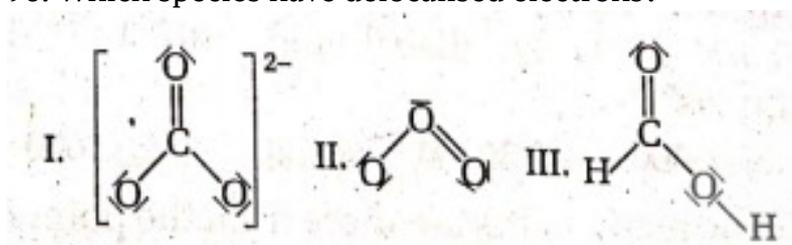
95. Choose the most appropriate options.

Which one of the following electrolytes is most effective for the coagulation of $\text{Fe}(\text{OH})_3$ sol?

- (a) NaCl
- (b) Na_2SO_4
- (c) Na_3PO_4
- (d) As_2S_3

Correct: c

96. Which species have delocalised electrons?



- (a) I and II
- (b) I and III
- (c) II and III
- (d) All of the above

Correct: a

97. Choose the most appropriate options.

Arrange the following compounds in the increasing order of their reactivity towards HCN

- I. Acetaldehyde
- II. Acetone
- III. Di-tert-butyl ketone

- (a) II > I > IV > I
- (b) II > I > IV > II
- (c) IV > III > II > I
- (d) II > IV > I > I

Correct: c

98. The K_{sp} for $\text{Mn}(\text{OH})_2$ is 1.6×10^{-13} . What is the molar solubility of this compound in water?

- (a) $\sqrt[3]{40 \times 10^{-14}}$
- (b) 1.6×10^{-13}
- (c) $\sqrt[3]{40 \times 10^{-13}}$
- (d) $\sqrt{40 \times 10^{-14}}$

Correct: a

99. Choose the most appropriate options.

The magnetic moment of M^{x+} (atomic number = 25) is $\sqrt{15}BM$. Then, the oxidation number x of M is :

- (a) 3
- (b) 4
- (c) 2
- (d) 1

Correct: b

100. Choose the most appropriate options.

Arrange the following in the decreasing order of basic character .

- I. p-toluidine
- II. N,N-dimethyl-p-toluidine
- III. p-nitroaniline
- IV. Aniline

- (a) II > III > I > IV
- (b) I > II > III > IV
- (c) II > I > IV > III
- (d) IV > III > I > II

Correct: c

Mathematics

101. In how many ways can 10 identical objects be put in 8 distinct boxes in such that no box is empty?

- (a) 9
- (b) 36
- (c) 45
- (d) 10

Correct: b

102. Choose the most appropriate option.

$\lim_{x \rightarrow 1} x^{\frac{1}{(1-x)}}$ is equal to

- (a) 0
- (b) 3
- (c) 1/e
- (d) ∞

Correct: c

103. In how many ways can 3 blue, 4 white and 2 red balls be distributed into 4 distinct boxes?

- (a) 49000
- (b) 36750
- (c) 126
- (d) 7000

Correct: d

104. Choose the most appropriate options.

If α and β are non-real numbers satisfying

$$x^3 - 1 = 0, \text{ then the value of } \begin{vmatrix} \lambda + 1 & \alpha & \beta \\ \alpha & \lambda + \beta & 1 \\ \beta & 1 & \lambda + \alpha \end{vmatrix} \text{ is}$$

- (a) 0
- (b) λ^3
- (c) $\lambda^3 + 1$
- (d) $\lambda^3 - 1$

Correct: b

105. In how many ways can 5 men and 3 women be seated in a row such that no two women sit adjacently?

- (a) 720
- (b) 2400
- (c) 1440
- (d) 14400

Correct: d

106. Choose the most appropriate option.

$$\int_{-2}^2 \frac{3x^7 - 2x^5 + x^3 - 3}{x^4 + 3x^2 + 1} dx \text{ is equal to}$$

- (a) does not exist
- (b) 3
- (c) $1/e$
- (d) ∞

Correct: a

$$107. \begin{vmatrix} x + 1 & x + 2 & x + 4 \\ x + 3 & x + 5 & x + 8 \\ x + 7 & x + 10 & x + 14 \end{vmatrix}$$

Is equal to

- (a) 2

- (b) -4
 (c) 0
 (d) None of the above

Correct: d

108. Choose the most appropriate option.

In a class, there are 10 boys and 8 girls. When 3 students are selected at random, the probability that 2 girls and 1 boy are selected, is

- (a) $\frac{35}{102}$
 (b) $\frac{15}{102}$
 (c) $\frac{55}{102}$
 (d) $\frac{25}{102}$

Correct: a

$$109. \begin{vmatrix} b^2 + c^2 & c^2 & b^2 \\ c^2 & c^2 + a^2 & a^2 \\ b^2 & a^2 & a^2 + b^2 \end{vmatrix}$$

Is equal to

- (a) $4a^2b^2c^2$
 (b) $(a + b + c)^2$
 (c) $a^2 + b^2 + c^2$
 (d) $a^4 + b^4 + c^4$

Correct: a

110. Choose the most appropriate option.

If $y = b^{ax}$ then

- (a) $y_n = a^n b^{ax} (\log_e b)^{n-1}$
 (b) $y_n = (-1)^n a^n b^{ax} (\log_e b)^n$
 (c) $y_n = a^{n+1} b^m (\log_e b)^n$
 (d) $y_n = a^n b^{ax} (\log_e b)^n$

Correct: d

111. Let S be the set of all points with coordinates (x, y, z), where x,y and z are each chosen from the set [0, 1, 2). How many equilateral triangles have all their vertices in S?

- (a) 72
 (b) 76
 (c) 80
 (d) 84

Correct: a

112. Choose the most appropriate option.

The value of the integral $\int_{-3}^5 |x - 3| dx$ is

- (a) 20
- (b) 21
- (c) 18
- (d) 22

Correct: a

113. Six ants simultaneously stand on the six vertices of a regular octahedron with each ant at a different vertex. Simultaneously and independently, each ant moves from its vertex to one of the four adjacent vertices, each with equal probability. What is the probability that no two ants arrive at the same vertex?

- (a) $\frac{5}{256}$
- (b) $\frac{21}{1024}$
- (c) $\frac{11}{512}$
- (d) $\frac{23}{1024}$

Correct: b

114. Choose the most appropriate options.

If A and B are independent events such that $P(B) = \frac{2}{7}$, $P(A \cup \bar{B}) = 0.8$ then $P(A) =$

- (a) 0.1
- (b) 0.2
- (c) 0.3
- (d) 0.4

Correct: c

115. $1 + 1 + \frac{3}{2^2} + \frac{4}{2^3} + \frac{5}{2^4} + \dots$ is equal to

- (a) 1
- (b) 2
- (c) 3
- (d) 4

Correct: d

116. Choose the most appropriate option.

The line $y = mx + c$ will be tangent to the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ if c is equal to

- (a) $\frac{3}{m}$
- (b) $\sqrt{9m^2 + 4}$
- (c) $\sqrt{1 + m^2}$

(d) $\sqrt{4m^2 + 9}$

Correct: b

117. Determine the form of the conic section described by the equation

$$x^2 + y^2 + 2xy - 8x + 8y = 0$$

- (a) Circle
- (b) Parabola
- (c) Hyperbola
- (d) A pair of straight lines

Correct: b

118. Choose the most appropriate options.

Let $P = \{\theta : \sin \theta - \cos \theta = \sqrt{2} \cos \theta\}$ and, $Q = \{\theta \sin \theta + \cos \theta = \sqrt{2} \sin \theta\}$ be two sets.

Then,

- (a) $P \subset Q$ and $Q - P \neq \phi$
- (b) $Q \notin P$
- (c) $P \notin Q$
- (d) $P = Q$

Correct: d

119. $8 \cos^4 x - 8 \cos^2 x + 1$ is equal to

- (a) $\cos 4x$
- (b) $\sin 4x$
- (c) $\cos 2x - \sin 4x$
- (d) $\cos 2x + \sin 4x$

Correct: a

120. Choose the most appropriate options.

If a, b, c are positive real numbers, then $\frac{1}{\log_{ab}^{abc}} + \frac{1}{\log_{bc}^{abc}} + \frac{1}{\log_{ca}^{abc}} =$

- (a) 0
- (b) 1
- (c) 2
- (d) 3

Correct: c

121. Find the distance from the point A(2, 3, -1) to the given straight lines $2x - 2y + z + 3 = 0$ and $3x - 2y + 2z + 17 = 0$.

- (a) $1/\sqrt{5}$
- (b) 19.13
- (c) $3/\sqrt{5}$

(d) $6/\sqrt{5}$

Correct: b

122. Choose the most appropriate options.

If $\sin \theta + \csc \theta = 2$ then the value of $\sin^{10} \theta + \csc^{10} \theta$

- (a) 2
- (b) 2^4
- (c) 2^8
- (d) 2^{10}

Correct: a

123. $\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{vmatrix}$ is equal to

- (a) -1
- (b) 0
- (c) 1
- (d) None of these

Correct: b

124. Choose the most appropriate options.

The standard deviation of a data is 6, when each observation is increased by 1, then the standard deviation of new data is

- (a) 5
- (b) 7
- (c) 6
- (d) 8

Correct: c

125. Compute the determinant of the $n \times n$ matrix whose elements are identified by the condition $a_{ij} = \min(i, j)$ where i is the row number and j is the column number.

- (a) -1
- (b) $(-1)^n$
- (c) 1
- (d) 0

Correct: c

126. Choose the most appropriate options.

Let T_n denote the number of triangles which can be formed using the vertices of a regular polygon of n sides. If $T_{n+1} - T_n = 21$ then n equals

- (a) 5
- (b) 7
- (c) 6
- (d) 8

Correct: b

127. Find $\frac{dy}{dx}$ where $a^{\frac{x}{y}} = \left(\frac{x}{y}\right)^a$

- (a) xy
- (b) $\frac{y}{x}$
- (c) $\frac{x}{y}$
- (d) Does not exist

Correct: b

128. Choose the most appropriate options.

If the arithmetic mean of the following data is 7 then $a+b=$

x_i	4	6	7	9
f_i	a	4	b	5

- (a) 4
- (b) 2
- (c) 3
- (d) cannot be determined

Correct: d

129. $\int 3^{4x} dx$ is equal to

- (a) $\frac{3^{6x}}{4} + C$
- (b) $\frac{3^{4x}}{\ln 3} + C$
- (c) $\frac{3^{4x}}{3 \ln 4} + C$
- (d) $\frac{3^{4x}}{4 \ln 3} + C$

Correct: d

130. $\int e^{\sec x} \tan x \sec x dx$ is equal to

- (a) $e^{\tan x} + C$
- (b) $e^{\sec x} + C$
- (c) $e^{\sec x} \sec x + C$
- (d) $e^{\sec x} \tan x + C$

Correct: b

131. Choose the most appropriate option.

Solve for x ($a \neq 0$)

$$\sqrt[3]{(a+x)^2} + 4\sqrt[3]{(a-x)^2} = 5\sqrt[3]{a^2 - x^2}$$

- (a) $x_1 = \frac{43}{45}a, x_2 = \frac{63}{65}a$
 (b) $x_1 = \frac{43}{45}a, x_2 = 0$
 (c) $x_1 = \frac{63}{65}a, x_2 = 0$
 (d) $x_1 = -\frac{63}{65}a, x_2 = 0$

Correct: c

132. $\int_0^{\pi/2} e^x \cos x dx$ is equal to

- (a) $\frac{1}{2}(e - 1)$
 (b) $\frac{1}{2}(e^x - 1)$
 (c) $\frac{1}{2}(e^{\pi/2} - 1)$
 (d) $\frac{1}{2}(1 - e^{\pi/2})$

Correct: c

133. Find the area of the figure bounded by the parabola $y^2 = 4x$ and $x^2 = 4y$

- (a) 16
 (b) 8
 (c) $16/3$
 (d) 4

Correct: c

134. Choose the most appropriate options.

The eccentricity of the hyperbola $\frac{\sqrt{1999}}{3}(x^2 - y^2) = 1$ is

- (a) $\sqrt{2}$
 (b) 2
 (c) $2\sqrt{2}$
 (d) $\sqrt{3}$

Correct: a

135. Consider sequences of positive real numbers of the form $x, 2000, y, \dots$, in which every term after the first is 1 less than the product of its two immediate neighbours. For how many different values of x does the term 2001 appear somewhere in the sequence?

- (a) 1
 (b) 2
 (c) 3

(d) 4

Correct: d

136. Choose the most appropriate options.

The exradii of a triangle, r_1, r_2, r_3 are in harmonic progression, then the sides a, b and c are in

- (a) (-0,1)
- (b) (2,3)
- (c) (-0,3)
- (d) (-0,1)+(2,3)

Correct: b

137. Let $f(x) = x^2 + 6x + 1$ and let R denotes the set of points (x,y) in the coordinate plane such that $f(x) + f(y) \leq 0$ and $f(x) - f(y) \leq 0$. Which of the following is closest to the area of R?

- (a) 22
- (b) 23
- (c) 24
- (d) 25

Correct: d

138. Let n be a 5-digit number and let q and r be the quotient and remainder respectively, when n is divided by 100. For how many values of n is q+r divisible by 11?

- (a) 8180
- (b) 8181
- (c) 8182
- (d) 9000

Correct: b

139. Choose the most appropriate options.

If $\tan \frac{2\pi}{18}, x$ and $\tan \frac{7\pi}{18}$ are in AP and $\tan \frac{2\pi}{18}, y$ and $\tan \frac{5\pi}{18}$ are in AP then the value of x/y will be

- (a) 1/2
- (b) 2
- (c) 1
- (d) 1/4

Correct: b

140. A line segment with the end points A (3,-2) and B (6, 4) is divided into three equal parts. Find the coordinates of the division points.

- (a) (4, 0), (5,2)
- (b) (0,4), (5,2)

- (c) (4,0), (2,5)
 (d) (0,4), (2,5)

Correct: a

141. Three mutually tangent spheres of radius 1 rest on a horizontal plane. A sphere of radius 2 rests on them. What is the distance from the plane to the top of the larger sphere?

- (a) $3 + \frac{\sqrt{30}}{2}$
 (b) $3 + \frac{\sqrt{69}}{3}$
 (c) $3 + \frac{\sqrt{123}}{4}$
 (d) $\frac{52}{9}$

Correct: b

142. Choose the most appropriate options.

If the line $x-1=0$ is the directrix of the parabola $y^2 - kx + 8 = 0$ then one of the value of k is

- (a) $1/8$
 (b) 8
 (c) 4
 (d) $1/4$

Correct: c

143. $\lim_{x \rightarrow 0} (1 + \tan^2 \sqrt{x})^{3/x}$ is equal to

- (a) 0
 (b) ∞
 (c) e
 (d) e^3

Correct: d

144. $\lim_{x \rightarrow a} \frac{\log a^x - 1}{x - a}$ is equal to

- (a) 0
 (b) ∞
 (c) $\log_a e$
 (d) $\frac{1}{a} \log_a e$

Correct: d

145. Choose the most appropriate options.

For real x, let $f(x) = x^3 + 5x + 1$, then

- (a) f is one-one but not onto R
 (b) f is onto R but not one-one
 (c) f is one-one and onto R

(d) f is neither one-one nor onto \mathbb{R}

Correct: c

146. $\lim_{x \rightarrow 0} \frac{1 - \cos 4x}{2 \sin^2 x + x \tan 7x}$ is equal to

- (a) $8/9$
- (b) 0
- (c) $9/8$
- (d) ∞

Correct: a

147. Choose the most appropriate options.

Negation of the statement $(p \wedge r) \rightarrow (r \vee q)$ is

- (a) $(p \wedge r) \wedge (-r \wedge \neg q)$
- (b) $\neg(p \wedge r) \rightarrow \sim(r \vee q)$
- (c) $\neg(p \vee r) \rightarrow \neg(r \wedge q)$
- (d) $(p \wedge r) \vee (r \vee q)$

Correct: a

148. Given the vertices of a triangle are A (1, -1, -3), B (2, 1, -2) and C (-5, 2, -6). Compute the length of the bisector of the interior angle at vertex A.

- (a) 3
- (b) $\sqrt{10}/4$
- (c) $\frac{3\sqrt{10}}{4}$
- (d) $3\sqrt{10}$

Correct: c

149. It is known that $\vec{AB} = 2\vec{a} - 6\vec{b}$ and $\vec{AC} = 3\vec{a} + \vec{b}$, where \vec{a} and \vec{b} are mutually perpendicular unit vectors. Determine the angles of the $\triangle ABC$.

- (a) $\pi/6$
- (b) $\pi/4$
- (c) $\pi/2$
- (d) π

Correct: c

150. Choose the most appropriate options.

The value of $\int \frac{\sin^2 x \cos^2 x}{(\sin^3 x + \cos^3 x)^2} dx$, is

- (a) $\frac{1}{3(1 + \tan^3 x)} + C$

(b) $-\frac{1}{3(1+\tan^5 x)} + C$

(c) $\frac{1}{1+\tan^3 x} + C$

(d) $\frac{-1}{1+\tan^3 x} + c$

Correct: b

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