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PAPER – I PHYSICS & CHEMISTRY-2019

Version Code	A1	Question Booklet Serial Number:	5104300

Time: 150 Minutes	Number of Questions : 120	Maximum Marks : 480

Name of the Candidate	
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INSTRUCTION TO CANDIDATES

1. **Please ensure that the VERSION CODE shown at the top of this Question Booklet is same as that shown in the OMR Answer Sheet issued to you.** If you have received a Question Booklet with a different Version Code, please get it replaced with a Question Booklet with the same Version Code as that of OMR Answer Sheet from the Invigilator. **THIS IS VERY IMPORTANT.**
2. Please fill the items such as Name, Roll Number and Signature in the columns given above. Please also write Question Booklet Serial Number given at the top of this page against item 3 in the OMR Answer Sheet.
3. This Question Booklet contains 120 questions. For each question five answers are suggested and given against (A), (B), (C), (D), and (E) of which only one will be the '**Most Appropriate Answer.**' Mark the bubble containing the letter corresponding to the 'Most Appropriate Answer' in the OMR Answer Sheet, by using either **Blue or Black Ball Point Pen only.**
4. **Negative Marking**: In order to discourage wild guessing the score will be subjected to penalization formula based on the number of right answers actually marked and the number of wrong answer marked. Each correct answer will be awarded FOUR marks. ONE mark will be deducted for each incorrect answer. More than one answer marked against a question will be deemed as incorrect answer and will be negatively marked.
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SEAL

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PLEASE ENSURE THAT THIS QUESTION BOOKLET CONTAINS 120 QUESTIONS SERIALLY NUMBERED FROM 1 TO 120. PRINTED PAGES 32.

1. The dimensions for pressure is

   (A) MLT^{-2} (B) $ML^{-1}T^{-2}$ (C) $M^{-1}L^{-1}T^{-2}$

   (D) $ML^{-1}T^{-1}$ (E) MLT

2. The magnitude of deceleration required for a body, moving at a speed of 10 m/s to come to a complete halt at a distance of 100 m is

   (A) 20 m/s^2 (B) 10 m/s^2 (C) 2 m/s^2

   (D) 0.5 m/s^2 (E) 1 m/s^2

3. An accurate measurement implies that

   (A) the spread of the readings are broad around the mean value

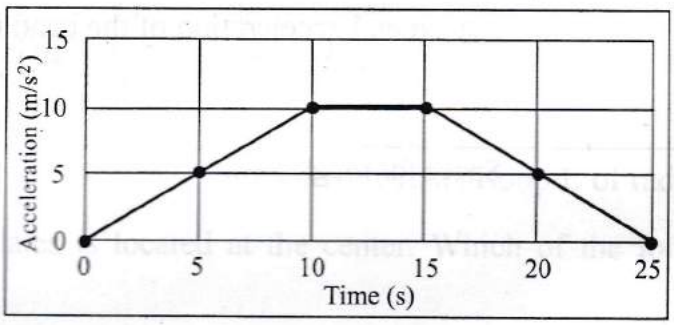
   (B) the spread of the readings are narrow around the mean value

   (C) the mean value of the readings is always lower than the true value

   (D) the mean value of the readings is always higher than the true value

   (E) the closeness of the mean of the readings to the true value

4. The following plot gives the variation of acceleration (m/s^2) with time (s) for an object that started from rest at time $t = 0$ s. The velocity at time $t = 15$ s (V15) and at 25 s (V25), respectively are



   (A) V15 = 50 m/s and V25 = 0 m/s (B) V15 = 100 m/s and V25 = 150 m/s

   (C) V15 = 50 m/s and V25 = 25 m/s (D) V15 = 100 m/s and V25 = 25 m/s

   (E) V15 = 75 m/s and V25 = 50 m/s

Space for rough work

5. An object, moving with velocity 5 m/s, undergoes an acceleration of 1 m/s^2 at time $t = 0$. If the object has a mass of 1 kg, the kinetic energy (KE) of the object at time $t = 5$ s is

(A) KE = 12.5 Joules (B) KE = 20 Joules (C) KE = 30 Joules
(D) KE = 50 Joules (E) KE = 0 Joules

6. The variation of speed (in m/s) of an object with time (in seconds) is given by the expression $V(t) = V_0 - 5t + 5t^2$

(A) At time $t = 0$ s, the instantaneous acceleration is zero
(B) At time $t = 0$ s, there is a deceleration of the object
(C) At time $t = 1$ s, the object is at rest
(D) At time $t = 1$ s, the instantaneous acceleration is zero
(E) The distance travelled by the object at time $t = 1$ s is V_0 m

7. A boat is moving from the east bank to the west bank on a south flowing river. If the speed of the boat is 4 km/h and that of the river is 3 km/h. If the width of the river is 2 km, the distance travelled by the boat is

(A) 5 km (B) 4 km (C) 3 km
(D) 2.5 km (E) 2 km

8. A bead is tied on one end of a stiff rope of length 1 m. With the other end of the rope as the center, the rope is rotated in such a way that the bead completes 10 revolutions per second. The centripetal acceleration of the bead is

(A) $400\pi^2$ m/s^2 (B) $200\pi^2$ m/s^2 (C) 400 m/s^2
(D) 200 m/s^2 (E) 100 m/s^2

Space for rough work

9. The electric field of an electromagnetic wave in free space is given by $\vec{E} = 5\sin\left(\frac{2\pi}{3}z - \omega t\right)\hat{y}$ V/m. Which of the following statements is **correct**?

(A) The wave propagates along $\hat{y}$

(B) The wave vector is given $\vec{k} = \frac{2\pi}{3}\hat{z}$

(C) The wavelength of the electromagnetic wave is $\frac{1}{3}$ m

(D) The corresponding magnetic field is $\vec{B} = \frac{5}{c}\cos\left(\frac{2\pi}{3}z - \omega t\right)\hat{x}$ T

(E) The frequency of the wave is approximately 10^6 Hz

10. The radiation produced by a 100 W bulb has the following property

(A) The radiation is in the form of an electromagnetic wave which carries energy but not momentum

(B) The radiation is in the form of an electromagnetic wave which carries momentum but not energy

(C) The radiation is in the form of an electromagnetic wave which carries both energy and momentum

(D) The radiation neither carries energy nor momentum

(E) The intensity of radiation is independent of the distance from source

11. A parallel plate capacitor (of capacitance C) with circular plates of radius r_0 located at positions ± α, is connected in series with a resistor R and is charged by a battery of voltage V. Consider a circular loop L of radius $\frac{r_0}{2}$ parallel to the capacitor plates is located at the center. Which of the following statements is **correct**?

(A) The charge on the capacitor at time t is $q(t) = \mathrm{CR}\left(1 - e^{-t/(\mathrm{CV})}\right)$

(B) The charge on the capacitor at time t is $q(t) = \mathrm{CV}\left(1 - e^{-t/(\mathrm{CV})}\right)$

(C) The flux through the loop L is independent of the area enclosed by it

(D) The magnetic field is directed orthogonal to the loop L

(E) The magnetic field is directed along the loop L

Space for rough work

12. A monochromatic light of frequency $\nu = \frac{1}{6.63} \times 10^{16}$ Hz is produced by a laser. The power emitted is $P = 10^{-2}$ W. The average number of photons per second emitted by the source is

(A) $\frac{1}{(6.63)^2} \times 10^{16}$ (B) $(6.63)^2 \times 10^{20}$ (C) $(6.63)^2 \times 10^{16}$

(D) 10^{20} (E) 10^{16}

13. The work function of three photosensitive materials used to build photoelectric devices are given as: Sodium (2.75 eV), copper (4.65 eV) and gold (5.1 eV). Which of the following statements is **correct**. (The frequency of visible light lies in the range 4×10^{14} Hz to 8×10^{14} Hz)?

(A) Devices built by copper and gold can operate with visible light
(B) Devices built using sodium can operate with ultraviolet light
(C) All the devices can operate with infrared light
(D) All the devices can operate with visible light
(E) No device can operate with visible light

14. An object is placed at 9 cm in front of a concave mirror of radius of curvature 12 cm. The following statement is **true**

(A) The image is formed 36 cm behind the mirror
(B) The image is 36 cm in front of the mirror
(C) The image is magnified, virtual and erect
(D) The image is magnified, real and erect
(E) The image is magnified, real and inverted

15. An optician prescribes a lens of power +2.5 D. The focal length of the lens in water is (Refractive indices of the lens and water are respectively 1.5 and 1.33)

(A) 40 cm (B) 2660/17 cm (C) 17/2660 cm
(D) 3000/17 cm (E) 17/3000 cm

Space for rough work

16. In a single slit diffraction (of width α) by a monochromatic source of wavelength λ the first minimum of the intensity distribution occurs at an angle

(A) $\frac{\lambda}{\alpha}$ (B) $\frac{\lambda}{2\alpha}$ (C) $\frac{\alpha}{\lambda}$

(D) $\frac{\alpha}{2\lambda}$ (E) $\frac{\pi}{4}$

17. A monochromatic source of wavelength 600 nm was used in Young's double slit experiment to produce interference pattern. I_1 is the intensity of light at a point on the screen where the path difference is 150 nm. The intensity of light at a point where the path difference is 200 nm is given by

(A) $\frac{1}{2} I_1$ (B) $\frac{3}{2} I_1$ (C) $\frac{2}{3} I_1$

(D) $\frac{3}{4} I_1$ (E) $\frac{4}{3} I_1$

18. The Brewster's angle for air to water interface is

(A) $\tan^{-1}(1.33)$ (B) $\sin^{-1}(1.33)$ (C) $\cos^{-1}(1.33)$

(D) $\tan^{-1}\left(\frac{1}{1.33}\right)$ (E) $\sin^{-1}\left(\frac{1}{1.33}\right)$

19. A TV transmitting antenna is 81 m tall. It has a half-power beam width of 10 degrees. If the receiving antenna is at the ground level, the service area covered by the transmitter is determined by

(A) the half-power beam width, the height of the transmitter and the radius of the earth
(B) the height of the transmitter and the radius of the earth
(C) the half-power beam width and the radius of the earth
(D) the height of the transmitter and the half-power beam width
(E) the height of the transmitter

Space for rough work

20. In the amplitude modulation mode of transmission, the normal speech signal is with a maximum frequency of 5 kHz. If the carrier frequency is 200 kHz, the modulated signal will have the frequencies varying between

(A) 190 kHz to 210 kHz (B) 195 kHz to 205 kHz (C) 195 kHz to 200 kHz
(D) 200 kHz to 205 kHz (E) 199.5 kHz to 200.5 kHz

21. For signal transmission, modulation is necessary

(A) to reduce distortion of the signal
(B) to modify the frequency content of the signal
(C) to mask the signal information from enemy
(D) to radiate the signal to a large distance using antennas
(E) to make it easy to amplify the signal

22. A light emitting diode is

(A) a n-p-n type semiconductor with a forward bias
(B) a p-n-p semiconductor with a reverse bias
(C) a p-n-p semiconductor with a forward bias
(D) a p-n semiconductor with a reverse bias
(E) a p-n semiconductor with a forward bias

23. In the context of p-n junction, select the **correct** statement from the following

(A) The barrier potential remains constant under forward bias
(B) The width of the depletion region depends on the doping level in the p-type and n-type regions
(C) Under forward bias condition, the p-n junction behaves like a pure resistor irrespective of bias voltage
(D) Under reverse bias condition, the p-n junction behaves like a pure resistor irrespective of bias voltage
(E) The barrier potential decreases under reverse bias

Space for rough work

24. The radius of gyration about an axis through the center of a hollow sphere with external radius a and internal radius b is

(A) $\sqrt{\frac{2}{5}\frac{(a^3-b^3)}{(a^5-b^5)}}$ (B) $\sqrt{\frac{1}{4}\frac{(a^4-b^4)}{(a^2-b^2)}}$ (C) $\sqrt{\frac{1}{2}\frac{(a^5-b^5)}{(a^3-b^3)}}$

(D) $\sqrt{\frac{2}{5}\frac{(a^5-b^5)}{(a^3-b^3)}}$ (E) $\sqrt{\frac{5}{2}\frac{(a^4-b^4)}{(a^2-b^2)}}$

25. A ball of mass 1 kg and radius 0.5 m, starting from rest rolls down on a 30° inclined plane. The torque acting on the ball at the distance of the 7 m from the starting point is close to
(Take acceleration due to gravity as 10 m/s^2)

(A) 0.25 N-m (B) 0.7 N-m (C) 0.5 N-m
(D) 0.4 N-m (E) 1.4 N-m

26. If the radius of the earth suddenly decreases by half of its present value. Then the time duration of one day will be

(A) 6 hours (B) 8 hours (C) 12 hours
(D) 24 hours (E) 48 hours

27. A hollow sphere and a solid sphere, of equal mass and equal radii roll down without slipping on an inclined plane. If the torque experienced by the hollow sphere and solid sphere are τ_H and τ_S respectively, then

(A) $\tau_H < \tau_S$ (B) $\tau_H > \tau_S$ (C) $\tau_H = \tau_S$
(D) $\tau_H = 0$ (E) $\tau_S = 0$

28. A brick of mass 2 kg slides down an incline of height 5 m and angle 30°. If the coefficient of friction of the incline is $\frac{1}{2\sqrt{3}}$, the velocity of the block at the bottom of the incline is
(Assume the acceleration due to gravity is 10 m/s^2)

(A) 5 m/s (B) 50 m/s (C) 7 m/s
(D) 0 (E) 10 m/s

Space for rough work

29. A spherically uniform planet of mass 8×10^{24} kg and of radius 6×10^{6} m is orbiting around the Sun. The escape velocity for the planet is close to (Take $G = 6 \times 10^{-11}$ N-m^2/kg^2)

(A) 11.2 km/s (B) 16 km/s (C) 4 km/s
(D) 12.6 km/s (E) 1.6 km/s

30. Suppose two planets A and B revolve around a Sun in the galaxy. The semi-major axis of A and B are 1 and 5 AU (astronomical unit) respectively. If the period of revolution of A is 1 year, the period of revolution of B is

(A) 1 year (B) 5 years (C) 11 years
(D) 25 years (E) 125 years

31. The half-life of $_{43}Tc^{99}$ is 6 hours. If 12 mg of $_{43}Tc^{99}$ is injected to a patient, after 24 hours how much Tc will be left in the patient's body?

(A) 0 mg (B) 0.75 mg (C) 3 mg
(D) 6 mg (E) 12 mg

32. For atoms, which of the following statement is **correct**?

(A) Heavier nuclei have more neutrons than protons
(B) Heavier nuclei have equal number of protons and neutrons
(C) Lighter nuclei have more neutrons than protons
(D) Lighter nuclei have less number of neutrons than protons
(E) For heavier nuclei, atomic mass varies as square of atomic number

33. Which of the following statements is **not** a property of nuclear force?

(A) it is an attractive force
(B) it is independent of interacting nucleons
(C) it is a long range force
(D) it is non-central force
(E) it is a short range force

34. Which of the following elements you need to remove to form an isotone family?

(A) $_{8}O^{16}$ (B) $_{7}N^{15}$ (C) $_{6}C^{14}$
(D) $_{13}Al^{27}$ (E) $_{9}F^{17}$

Space for rough work

35. A magnetic field of 1 T applied at an angle $\pi/3$ to the vertical direction is decreased to zero at a steady rate in one second. The magnitude of induced emf in a horizontally placed circular loop of radius 5 cm is given by

(A) $1.25\sqrt{3}\pi$ mV (B) $12.5\sqrt{3}\pi$ V (C) 1.25π mV

(D) 12.5π V (E) 25π V

36. The dimension of mutual inductance is (Denote dimension of current as A)

(A) $M L^2 T^2 A^{-2}$ (B) $M L^2 T^{-2} A^{-2}$ (C) $M L^{-2} T^2 A^{-2}$

(D) $M L^2 T^{-3} A^{-1}$ (E) $M L^2 T^{-3} A^{-3}$

37. A pure inductor of inductance 0.1 H is connected to an AC source (of rms voltage) 220 V and angular frequency of 300 Hz. The rms current is

(A) $\frac{3}{22}$ A (B) $\frac{22}{3}$ A (C) $\frac{11}{150}$ A

(D) $\frac{150}{11}$ A (E) $\frac{11}{3\pi}$ A

38. In an LCR series circuit (of inductance L, capacitance C and resistance R), the impedance is minimum when the angular frequency of the source is given by

(A) $\sqrt{LC}$ (B) $\frac{1}{\sqrt{LC}}$ (C) $\sqrt{\frac{L}{C}}$

(D) $\sqrt{\frac{C}{L}}$ (E) $\sqrt{LCR}$

Space for rough work

39. A Carnot engine is operating between a hot body and cold body maintained at temperatures T_1 and T_2 respectively. Consider the following three cases

Case-I : The temperature of the hot body is changed to $T_1 + \Delta T$ and cold body is at T_2

Case-II: The temperature of the hot body is at T_1 and cold body is changed to $T_2 + \Delta T$

Case-III: The temperature of the hot body is at T_1 and cold body is changed to $T_2 - \Delta T$

(A) The efficiency of the Carnot cycle is highest for case-I

(B) The efficiency of the Carnot cycle is highest for case-II

(C) The efficiency of the Carnot cycle is highest for case-III

(D) The efficiency of case-II is higher than case-III

(E) The efficiency of the Carnot cycle is same for all three cases

40. Some smoke is trapped in a small glass container and is viewed through a microscope. A number of very small smoke particles are seen in continuous random motion as a result of their bombardment by air molecules. If the mass of the smoke particle is about 10^{12} times higher than that of an air molecule the average speed of a smoke particle is

(A) 10^{6} times the average speed of an air molecule

(B) 10^{-12} times the average speed of an air molecule

(C) 10^{12} times the average speed of an air molecule

(D) 10^{-6} times the average speed of an air molecule

(E) 10^{-10} times the average speed of an air molecule

41. The standard of length is maintained by a 1 meter long bar made up of a material having coefficient of linear expansion $\alpha = 0.00001\ ^{\circ}C^{-1}$. If the length of the bar were to be preserved to an accuracy of 1 part per million, what would be maximum allowed temperature variation?

(A) $\pm 0.01\ ^{\circ}C$ (B) $\pm 0.1\ ^{\circ}C$ (C) $\pm 0.001\ ^{\circ}C$

(D) $\pm 0.0001\ ^{\circ}C$ (E) $\pm 1.0\ ^{\circ}C$

Space for rough work

42. Inside the engine of an automobile, the cylinder compresses the air from approximately standard temperature and pressure to one-twentieth of the original volume and a pressure of 50 atm. What is the temperature of the compressed air?

(A) 500 K (B) 682 K (C) 550 K
(D) 1000 K (E) 200 K

43. A spring of natural length l and spring constant 50 N/m is kept on a horizontal frictionless table with one end attached to a rigid support. First the spring was compressed by 10 cm and then released to hit a ball of mass 20 g kept at a distance l from the rigid support. If after hitting the ball, the natural length of the spring is restored, what is the speed with which the ball moved?
(Ignore the air resistance)

(A) 5 m/s (B) 7 m/s (C) 25 m/s
(D) 50 m/s (E) 2500 m/s

44. In a water container, an aluminum piece of volume 0.5 m^3 is lowered through an external force, until it is completely submerged. In another identical water container, a lead piece of same volume was similarly submerged using the same amount of external force. The mass density of lead is 4 times larger than the mass density of the aluminum. If F_A and F_L are the buoyancy forces acting on aluminum and lead respectively, then which of the following statements is **correct**?

(A) $F_A > 4\,F_L$ (B) $F_L > 4\,F_A$ (C) $F_A > 2\,F_L$
(D) $F_L > 2\,F_A$ (E) $F_L = F_A$

45. A boy formed a bubble and a liquid drop from the same soapy water. The pressure difference between inside and outside of the soap bubble is measured to be 100 N/m^2. If the radius of the droplet is half of the radius of the bubble, then the pressure difference between the inside and outside of the droplet is

(A) 0 (B) 50 N/m^2 (C) 100 N/m^2
(D) 200 N/m^2 (E) 400 N/m^2

Space for rough work

46. A mass m, suspended vertically by a massless ideal spring with spring constant k, is at rest. The mass is displaced upward by a height h. When released, the kinetic energy of the mass will be proportional to
(Neglecting air resistance)
(A) only h
(B) only h^2
(C) m
(D) a linear combination of terms involving h and h^2
(E) k

47. Instantaneous power delivered to a damped harmonic oscillator (natural frequency is ω_0) by an external periodic force (driving frequency ω) under steady state conditions is
(A) positive always
(B) negative always
(C) positive and negative with power integrated over a period being zero
(D) positive and negative with power integrated over a period being positive
(E) positive and negative with power integrated over a period being negative

48. The Q factor for a damped oscillator is given by the
(A) Ratio of energy stored per cycle to the initial energy
(B) Ratio of energy dissipated per cycle to the initial energy
(C) Ratio of energy stored per cycle to the energy dissipated per cycle
(D) Ratio of energy dissipated per cycle to the energy stored per cycle
(E) Ratio of the damping coefficient to the natural frequency

49. A ball of mass m is projected upward with a speed v_0. The speed at a height h is
(Neglecting air resistance)
(A) independent of angle and direction of projection
(B) independent of mass, angle and the direction of projection
(C) dependent on the direction of projection
(D) dependent on the shape, size and mass of the ball and angle of projection
(E) dependent on mass of the ball but independent of the angle and direction of projection

Space for rough work

50. An object having a velocity 5 m/s is accelerated at the rate 2 m/s^2 for 6 s. Find the distance travelled during the period of acceleration

(A) 60 m (B) 25 m (C) 36 m

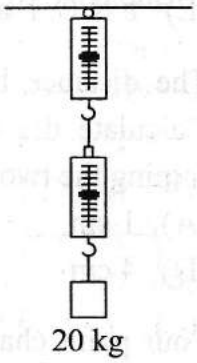
(D) 66 m (E) 45 m

51. A vehicle moving at 36 km/hr is to be stopped by applying brakes in the next 5 m. If the vehicle weighs 2000 kg, determine the average force that must be applied on it

(A) 10^4 N (B) 2×10^4 N (C) 3×10^4 N

(D) 5×10^3 N (E) 10^3 N

52. A block of mass 20 kg is suspended through two spring balances with negligible mass as shown in figure. What will be the readings in the upper and lower balance respectively?



(A) 0 kg, 20 kg

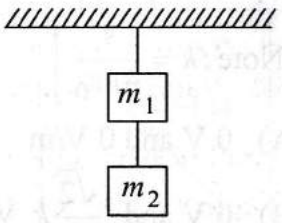
(B) 10 kg, 20 kg

(C) 20 kg, 10 kg

(D) 10 kg, 10 kg

(E) 20 kg, 20 kg

53. Two masses connected in series with two massless strings are hanging from a support as shown in the figure. Find the tension in the upper string



(A) m_1g

(B) $(m_1 - m_2)g$

(C) m_2g

(D) $(m_1 + m_2)g$

(E) $(m_1 \times m_2)g$

Space for rough work

54. An electron, placed in an electric field, experiences a force F of 1 N. What are the magnitude and direction of the electric field E at the point where the electron is located ($e = 1.6 \times 10^{-19}$ C)?

(A) $\frac{1}{e}$ N/C, F and E are along the same direction

(B) $\frac{1}{e}$ N/C, F and E are against each other

(C) $\frac{1}{e}$ N/C, F and E are perpendicular

(D) e N/C, F and E are against each other

(E) e N/C, F and E are perpendicular

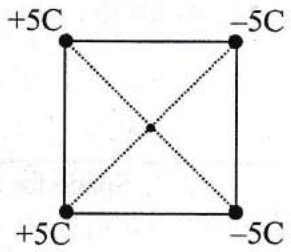
55. The distance between two charges $q_1 = +2$ μC and $q_2 = +8$ μC is 15 cm. Calculate the distance from the charge q_1 to the points on the line segment joining the two charges where the electric field is zero

(A) 1 cm (B) 2 cm (C) 3 cm

(D) 4 cm (E) 5 cm

56. Four point charges (with equal magnitude of charge of 5 C; but with different signs) are placed at four corners of a square of side 10 m. Assuming that the square is centered at the origin and the configuration of the charges are as given in the figure, the potential and the magnitude of electric field at the origin, respectively are

$\left[\text{Note}: k = \frac{1}{4\pi\varepsilon_0}\right]$



(A) 0 V and 0 V/m

(B) 0 V and $\frac{\sqrt{2}}{5}k$ V/m

(C) $\frac{\sqrt{2}}{5}k$ V and $\frac{\sqrt{2}}{5}k$ V/m

(D) 0 V and 5 V/m

(E) $\frac{\sqrt{2}}{5}k$ V and 0 V/m

Space for rough work

57. A point dipole with dipole moment, $\vec{p} = p_0 \hat{k}$, is kept at the origin. An external electric field given by, $\vec{E} = E_0(2\hat{i} - 3\hat{j} + 4\hat{k})$, is applied on it. Which one of the following statements is **true**?

(A) The force on the dipole is zero while torque rotates the dipole on the xy-plane

(B) The force on the dipole moves it along the direction of electric field

(C) The interaction energy between the dipole and electric field is zero

(D) The potential due to the dipole alone on the xy-plane with $z = 0$ depends on the value of p_0

(E) The application of the electric field orients the dipole along the $-\hat{k}$ direction

58. Find the total capacitance and total charge on the capacitors

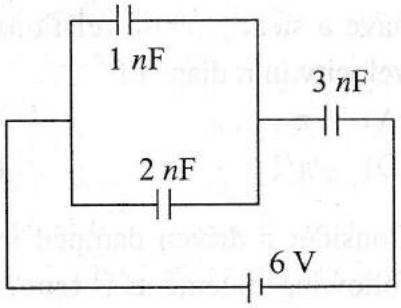
(A) 1.5 nF, 9 nC

(B) 3.0 nF, 18 nC

(C) 1.5 nF, 4.5 nC

(D) 3.0 nF, 9 nC

(E) 3.0 nF, 4.5 nC



59. A circuit is made using R_1, R_2, R_3, R_4 and a battery as shown in the following figure. Find the equivalent resistance of the given circuit and the current passing through R_3

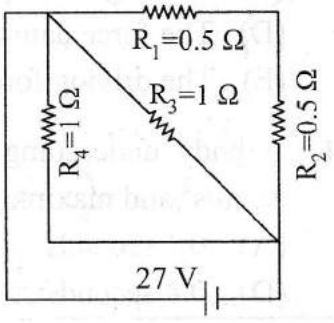
(A) 3 Ω, $\frac{1}{3}$ A

(B) $\frac{1}{3}$ Ω, 27 A

(C) $\frac{2}{3}$ Ω, $\frac{21}{2}$ A

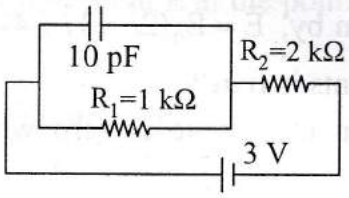
(D) $\frac{1}{3}$ Ω, $\frac{21}{2}$ A

(E) $\frac{2}{3}$ Ω, $\frac{21}{3}$ A



Space for rough work

60. Find the voltage and current passing through the resistor R_2 shown in the following circuit



(A) 3 V, 3 mA
(B) 1 V, 1 mA
(C) 3 V, 1 mA
(D) 1 V, 2 mA
(E) 2 V, 1 mA

61. The resistor $R_1 = 3\ \Omega$ and $R_2 = 1\ \Omega$ are connected in parallel to a 20 V battery. Find the heat developed in the resistor R_1 in one minute

(A) 600 J (B) 800 J (C) 6000 J
(D) 8000 J (E) 7000 J

62. The velocity and acceleration of a particle performing simple harmonic motion have a steady phase relationship. The acceleration shows a phase lead over the velocity in radians of

(A) $+\pi$ (B) 0 (C) $+\pi/2$
(D) $-\pi/2$ (E) $-\pi$

63. Consider a driven damped mechanical oscillator is in resonance. Which of the following statements is **true**?

(A) Driving frequency is twice the natural frequency of the oscillator
(B) Power transfer from the driving source to system is minimum
(C) Driving frequency is the same as the natural frequency of the oscillator
(D) The force damping the oscillations are at a minimum value
(E) The driving force is in phase with the displacement

64. A body undergoing simple harmonic motion has a maximum acceleration of $8\pi\ m/s^2$ and maximum speed of 1.6 m/s. What is the time period T?

(A) 0.1 seconds (B) 0. 2 seconds (C) 0.3 seconds
(D) 0.4 seconds (E) 0.5 seconds

Space for rough work

65. A bat emits an ultrasonic sound wave at 33.0 kHz and receives an echo 0.1 s later. What is the distance of the bat from the object-producing echo? (Speed of sound in air is 330 m/s)

(A) 10.0 m (B) 20.0 m (C) 33.0 m
(D) 66.0 m (E) 16.5 m

66. A wave along a string has the following equation $y = 0.05 \sin (28t - 2.0x)$ m (where t is in seconds and x is in meters). What are the amplitude, frequency and wavelength of the wave?

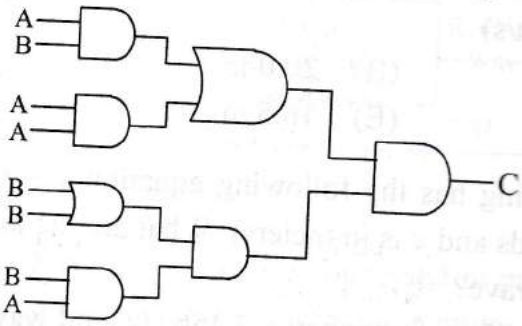
(A) amplitude = 0.05 m, frequency = 4.456 Hz and wavelength =3.518 m
(B) amplitude = 0.05 m, frequency = 28 Hz and wavelength =2.0 m
(C) amplitude = 5.0 m, frequency = 4.456 Hz and wavelength =3.518 m
(D) amplitude = 0.05 m, frequency = 2.0 Hz and wavelength = 28 m
(E) amplitude = 0.05 m, frequency = 3.456 Hz and wavelength =4.518 m

67. A train sounds its whistle as it approaches an observer standing at a point near the track. The observer measures a frequency of 216 Hz as the train approaches and a frequency of 184 Hz as the train leaves. What is the frequency of its whistle?

(A) 210 Hz (B) 190 Hz (C) 205 Hz
(D) 202 Hz (E) 200 Hz

Space for rough work

68. The following figure is the combination of logic gates. The inputs are A and B. The output is C. Which one of the following choices gives the correct matching?



(A)

A	B	C
0	0	1
0	1	1
1	0	1
1	1	1

(B)

A	B	C
0	0	1
0	1	0
1	0	1
1	1	0

(C)

A	B	C
0	0	0
0	1	1
1	0	0
1	1	1

(D)

A	B	C
0	0	1
0	1	1
1	0	0
1	1	0

(E)

A	B	C
0	0	0
0	1	0
1	0	0
1	1	0

69. A particle of mass m and charge q with an initial velocity $\vec{v}$ is subjected to a uniform magnetic field $\vec{B}$ along the vertical direction. The particle will

(A) follow a circular path if $\vec{v}$ is along the vertical direction

(B) make helical motion if $\vec{v}$ is along the horizontal direction

(C) make helical motion if $\vec{v}$ is neither parallel nor orthogonal to $\vec{B}$

(D) always make circular motion

(E) always make helical motion

Space for rough work

70. Consider a circular loop of radius R on the xy-plane carrying a steady current anticlockwise. The magnetic field at the center of the loop is given by

(A) $\frac{\mu_0}{2R} I\hat{x}$ (B) $\frac{\mu_0}{2R} I\hat{y}$ (C) $\frac{\mu_0}{2R} I\hat{z}$

(D) $\frac{\mu_0}{R} I\hat{x}$ (E) $\frac{\mu_0}{R} I\hat{y}$

71. Consider two parallel current carrying conductors separated by a distance. Which one of the following statements is **true**?

(A) Currents flowing in same direction will lead to repulsion
(B) Currents flowing in opposite directions will lead to attraction
(C) The conductors will always attract each other
(D) The conductors will always repel each other
(E) Currents flowing in same direction will lead to attraction and opposite directions will lead to repulsion

72. The energy gap is much more in silicon than in germanium because

(A) It has less number of electrons
(B) It has high atomic mass number
(C) Its crystal has much stronger bonds called ionic bonds
(D) Its valence electrons are more tightly bound to their parent nuclii
(E) Its valence electrons are more loosely bound to their parent nuclii

Space for rough work

73. NO^+ has bond order

(A) 2 (B) 2.5 (C) 3

(D) 3.5 (E) 4

74. Which hydride amongst the following has the least boiling point?

(A) NH_3 (B) PH_3 (C) AsH_3

(D) SbH_3 (E) BiH_3

75. Which of the following sets has Lewis acid behaviour for all the components?

(A) BF_3 (B) BF_3, SiF_4, PF_5 (C) SiF_4, PF_5

(D) BF_3, PF_5 (E) (A) and (B)

76. The carbon atoms in calcium carbide are held by

(A) Ionic bonds

(B) Two sigma bonds

(C) Two sigma and one coordinate bond

(D) One sigma and two π bonds

(E) One sigma and one π bond

77. According to the VSEPR theory, the shape of ClO_3^- would be

(A) Linear (B) Triangular planar (C) Pyramidal

(D) Square planar (E) Angular

78. Acetic acid in liquid ammonia behaves as

(A) Weaker acid than that in water

(B) Stronger acid than that in water

(C) Base acid

(D) Neutral acid

(E) (C) and (D)

79. The compound(s) that does(do) not exist is(are)

(A) BiF_5 (B) PF_5 (C) AsF_5

(D) SbF_5 (E) All the compounds exist

Space for rough work

80. Rare gases are sparingly soluble in water because of
(A) Hydrogen bonding
(B) Dipole–dipole interaction
(C) Induced dipole–induced dipole interaction
(D) Dipole–induced dipole interaction
(E) (A) and (D)

81. An example of a non-stoichiometric oxide when heated is
(A) BeO (B) ZnO (C) MgO
(D) CaO (E) Li_2O

82. The donor atom in EDTA are
(A) Two N and two O (B) Two N and four O (C) Four N and two O
(D) Three N and three O (E) Two N and three O

83. Hard acids prefer to combine with
(A) Soft bases (B) Soft acids (C) Hard acids
(D) Hard bases (E) Salts

84. Among the following, which species represents a pseudohalide?
(A) CN^- (B) CaO (C) I_2
(D) K_2HgI_4 (E) BiOCl

85. PCl_3 is stored in a well stoppered bottle since
(A) It decomposes in the presence of moisture
(B) It is decomposed by light
(C) It is highly volatile
(D) It reacts with air to form $POCl_3$
(E) (A) and (C)

86. An orange solid (A) on heating gives a green residue (B), a colourless gas (C) and water vapours. The dry gas (C) upon passing over heated Mg gave a white solid (D) which upon subsequent reaction with water gave a gas (E) that gave dense white fumes with HCl. Identify (D)
(A) $Fe(NH_3)Cl_2$ (B) CuN_2 (C) Mg_3N_2
(D) NH_4Cl (E) $FeCl_2$

Space for rough work

87. On passing silent electric discharge through oxygen in an ozonizer, 5.5 mol % of oxygen is converted to ozone. How many moles of O_2 and O_3 result when 35 moles of O_2 is originally present?

(A) 33.0 (B) 34.4 (C) 35.0
(D) 31.8 (E) 31.0

88. Carnallite is a mineral containing

(A) K (B) Na (C) Mg
(D) Fe (E) (A) and (C)

89. Maximum number of photons emitted by a bulb capable of producing monochromatic light of wavelength 550 nm is _____, if 100 V and 1 A is supplied for one hour.

(A) 1×10^{24} (B) 5×10^{24} (C) 1×10^{23}
(D) 5×10^{23} (E) 5×10^{22}

90. Which of the following is the correct unit of angular momentum of an electron in an orbital of an atom?

(A) J s (B) J / s (C) W / s^2
(D) W s (E) $J s^2$

91. Consider a *fcc* lattice made of a metal cation (M^{6+}) and three oxide anions per unit cell. The resultant structure would have

(A) 3D network of edge shared octahedra
(B) 3D network of corner shared octahedra
(C) 2D network of edge shared octahedra
(D) 2D network of corner shared octahedra
(E) 3D network of face shared octahedra

Space for rough work

92. The edge length of a solid possessing cubic unit cell is $2\sqrt{2}\,r$ (structure I), based on hard sphere model, which upon subjecting to a phase transition, a new cubic structure (structure II) having an edge length of $\frac{4r}{\sqrt{3}}$ is obtained, where r is the radius of the hard sphere. Which of the following statements is **true**?

(A) Density of the structure II is lower than structure I
(B) Density of structure II is higher than structure I
(C) The pore volume in structure I is 1.2 times higher than that of structure II
(D) The pore volume of both the structures are equal
(E) The octahedral voids in structure I is transformed into tetrahedral voids in structure II

93. An ideal gas "A" having volume of 1 L at 27 °C is kept in a container having movable piston and adiabatic walls in ambient condition. If 1.33 L atm of energy is supplied inside the system, find out the final temperature of the system?

(A) 399 K (B) 499 K (C) 599 K
(D) 299 K (E) 450 K

94. A 5.2 L closed container contains some water and $N_2(g)$ at 29 °C. The total pressure of the system and water tension are 1 atm and 0.04 atm, respectively. Upon electrolysing the liquid water inside completely, the final pressure of system was at 2 atm. What is number of moles of water that was present inside the container?

(A) $\frac{3.46}{RT}$ (B) $\frac{5.2}{RT}$ (C) $\frac{10.4}{RT}$
(D) $\frac{0.208}{RT}$ (E) $\frac{8.0}{RT}$

Space for rough work

95. A solution of methanol in water is 20 % by volume. If the solution and pure methanol have densities of 0.964 kg L^{-1} and 0.793 kg L^{-1}, respectively, find the per cent of methanol by weight?

(A) 15.8 (B) 16.45 (C) 20
(D) 14.8 (E) 17.6

96. The Henry's law constant for O_2 dissolved in water is 4.34×10^4 atm at certain temperature. If the partial pressure of O_2 in a gas mixture that is in equilibrium with water is 0.434 atm, what is the mole fraction of O_2 in the solution?

(A) 1×10^{-5}
(B) 1×10^{-4}
(C) 2×10^{-5}
(D) 1×10^{-6}
(E) 2×10^{-6}

97. The standard heat of formation of CH_4, CO_2 and H_2O (l) are –76.2, –394.8 and –285.82 kJ mol^{-1}, respectively. Heat of vaporization of water is 44 kJ mol^{-1}. Calculate the amount of heat evolved when 22.4 L of CH_4, kept under normal conditions, is oxidized into its gaseous products

(A) 802 kJ (B) 878.4 kJ (C) 702 kJ
(D) 788.4 kJ (E) 500 kJ

98. Acetic acid dimerizes when dissolved in benzene. As a result boiling point of the solution rises by 0.36°C, when 100 g of benzene is mixed with "X" g of acetic acid. In this solution, if experimentally measured molecular weight of acetic acid is 117.8 and molar elevation constant of benzene is 2.57 K kg mol^{-1}, what is the weight % and degree of dissociation (in %) of acetic acid in benzene?

(A) 1.62 and 98.3 (B) 0.81 and 98.3 (C) 0.5 and 86
(D) 1 and 98.3 (E) 1.4 and 99

99. At a certain temperature, 2 moles of CO and 4 moles of Cl_2 gases were reacted to form $COCl_2$ in a 10 L vessel. At equilibrium if one mole of CO is present then equilibrium constant for the reaction is

(A) 4 (B) 3.3 (C) 1
(D) 2.5 (E) 4.5

Space for rough work

100. The equilibrium constant for the reaction, $N_2(g) + 3H_2 \rightleftharpoons 2NH_3(g)$ and $2N_2(g) + 6H_2 \rightleftharpoons 4NH_3(g)$ are K_1 and K_2, respectively. The relationship between K_1 and K_2 is

(A) $K_2 = K_1^2$ (B) $K_2 = K_1^{-2}$ (C) $K_1 = K_2^2$

(D) $K_2 = \sqrt{K_1}$ (E) $K_1 = \sqrt{K_2}$

101. For a first order reaction, $A(g) \rightarrow B(g)$ at 35 °C, the volume of "A" left in the reaction vessel at various times are given below. [Given data: log(5/4) = 0.0969]

t / minutes	0	10	20	30	40
V / mL	25	20	15.7	12.5	9.6

What is the value of rate constant?

(A) 0.02231 min^{-1} (B) 0.04231 min^{-1} (C) 0.06231 min^{-1}

(D) 0.08231 min^{-1} (E) 0.1231 min^{-1}

102. E_{cell} of the following cell is

$Pt(s) \mid H_2(g), 1 \text{ bar} \mid H^+ (1 M) \parallel H^+ (0.1 M) \mid H_2(g), 1 \text{ bar} \mid Pt(s)$

(A) $\frac{-2.303RT}{F}$ (B) $\frac{2.303RT}{F}$ (C) $\frac{-2.303RT}{2F}$

(D) $\frac{2.303RT}{2F}$ (E) $\frac{RT}{2F}$

103. In a lead-acid battery, if 1 A current is passed to charge the battery for 1 h, what is the amount of $PbSO_4$ converted to PbO_2? (Given data: 1 F = 96500 C mol^{-1})

(A) 0.0373 moles (B) 0.0186 moles (C) 0.0093 moles

(D) 0.0268 moles (E) 0.0400 moles

Space for rough work

104. A fuel cell operates at constant current, with H_2 fuel (1 bar) and O_2 oxidant (1 bar). The electrolyte used is 0.001 M HCl and the product(s) of the reaction are confined inside the fuel cell. Which of the following is **true** about the electrolyte?

(A) Boiling point of the electrolyte decreases with increase in the duration of fuel cell operation

(B) Boiling point of the electrolyte increases with increase in the duration of fuel cell operation

(C) Open circuit voltage of the fuel cell remains constant with increase in duration of operation

(D) Open circuit voltage of the fuel cell increases with increase in duration of operation

(E) Both (A) and (C)

105. The correct IUPAC name for methylisopropylacetylene is

(A) 2-methyl-4-pentyne

(B) 4-methyl-2-pentyne

(C) isopropylmethylacetylene

(D) 3-methyl-4-pentyne

(E) 2-methyl-3-pentyne

106. Cyclohexylamine and aniline can be distinguished by

(A) Hinsberg's test (B) Carbylamine test (C) Bromine test

(D) Beilstein's test (E) Lassaigne's test

107. The compounds pyridine and planar cyclooctatetraene are _____, respectively

(A) aromatic and non-aromatic

(B) aromatic and anti-aromatic

(C) aromatic and aromatic

(D) anti-aromatic and non-aromatic

(E) anti-aromatic and anti-aromatic

Space for rough work

108. Propylene on treatment with HBr/H_2O_2 provides

(A) 1-bromopropane (B) 2-bromopropane (C) 1,2-dibromopropane
(D) 1-bromopropan-2-ol (E) 2-bromopropan-1-ol

109. _____ is a potent vasodilator.

(A) Histamine (B) Serotonin (C) Codeine
(D) Cimetidine (E) Aspirin

110. An invert sugar is

(A) Isorotatory (B) Levorotatory (C) Dextrorotatory
(D) Optically inactive (E) Mutarotatory

111. The strongest base among the following is

(A) NH_2^- (B) OH^- (C) $CH{=}C^-$
(D) $CH_3CH_2^-$ (E) OEt^-

112. The neopentyl halide in ethanol yields alkenes by E1 mechanism due to

(A) low concentration of solvent
(B) absence of base
(C) it is a primary halide
(D) steric factor which prevents E2 mechanism
(E) solvation effect

113. Arylbromides are not good candidates for

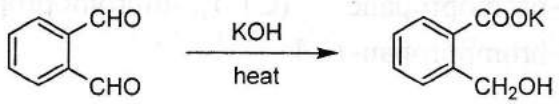
(A) Wurtz-Fittig reaction
(B) Fittig reaction
(C) Friedel-Crafts reaction
(D) Grignard reaction
(E) Gabriel-phthalimide synthesis

114. Sulfonation of benzene with excess sulfuric acid provides

(A) benzenesulfonic acid
(B) *p*-benzenedisulfonic acid
(C) *o*-benzenedisulfonic acid
(D) *m*-benzenedisulfonic acid
(E) decomposition of benzene

Space for rough work

115. The following reaction is named as



(A) Reimer-Tiemann
(B) Kolbe-Schmitt
(C) Cannizzaro
(D) Gattermann
(E) Aldol

116. When $C_6H_5COCOC_6H_5$ is reduced with $LiAlH_4$, the product formed has _____ stereoisomers.

(A) 2 (B) 3 (C) 4
(D) 6 (E) 8

117. The compound which does not lead to benzoic acid by oxidation with $KMnO_4$ is

(A) toluene (B) benzyl alcohol (C) *n*-butylbenzene
(D) *t*-butylbenzene (E) styrene

118. In the Hofmann rearrangement of primary amides having optically active group with S-configuration, the product amine has

(A) R-configuration
(B) S-configuration
(C) Racemic mixture
(D) Meso form
(E) Achiral nature

Space for rough work

119. Benzonitrile can be prepared from benzaldehyde on treatment with

(A) NH_3

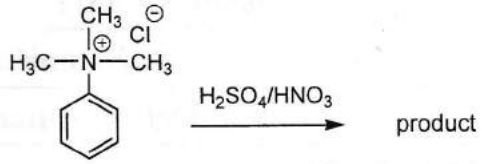
(B) NH_3 followed by hydrogenation with Ni

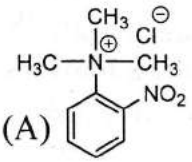
(C) NH_2OH

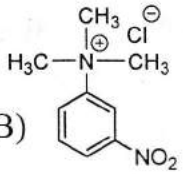
(D) NH_2OH followed by dehydration with acetic anhydride

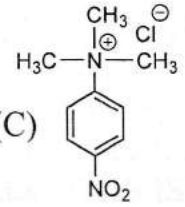
(E) Hydrogen cyanide

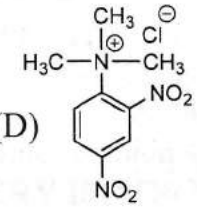
120. The product formed in the below reaction is

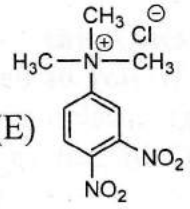


(A) 

(B) 

(C) 

(D) 

(E) 

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