1. Assume that a tunnel is dug along the diameter of the earth poles. A small body is dropped in to it so that the body performs simple harmonic motion. Neglect all the frictional forces and assume that earth has uniform density of ρ. The period of oscillation will be

(a) $\frac{2\pi}{\sqrt{\frac{4}{3}\pi G\rho}}$ (b) $\frac{2\pi}{\sqrt{\frac{4}{3}\pi\rho}}$ (c) $\frac{2\pi}{\sqrt{\frac{4}{3}\pi G}}$ (c) $\frac{2\pi}{\sqrt{G\rho}}$

2. A 1 g mass is suspended from a vertical spring. It executes simple harmonic motion with period 0.1 sec. By how much distance had the spring stretched when the mass was attached?

(a) 0.5 cm (b) 0.25 cm (c) 0.75 cm (d) 1.25 cm

3. A spherical soap bubble of radius 1.0 cm is formed inside another radius of 2.0 cm. The radius of single soap bubble which maintains the same pressure difference as inside the smaller and outside the large soap bubble is

(a) $6.67 \times 10^{-5}$m (b) $2.67 \times 10^{-5}$m (c) $2.67 \times 10^{-3}$m (d) $6.67 \times 10^{-3}$m

4. Twelve equal charges, q (same nature), are situated at the corners of a regular 12-sided planner polygon (for instance, one on each numeral of a clock face). The net force on a test charge Q at the center is (let r= be the distance between the charge 'q' to the test charge Q)

(a) Zero (b) $\frac{12qQ}{4\pi\varepsilon_0 r^2}$ (c) $\frac{6qQ}{4\pi\varepsilon_0 r^2}$ (d) $\frac{qQ}{4\pi\varepsilon_0 r^2}$

5. The potential at a point x (measured in μm) due to some charges situated on the x- axis is given by : $V(x) = \frac{20}{(x^2-4)}\ volt$. The electric field E at x= 4 μm is given by

(a) $\frac{5}{3}$ V/ μm and in the –ve x direction.

(b) $\frac{5}{3}$ V/ μm and in the +ve x direction

( c ) $\frac{10}{9}$ V/ μm and in the –ve x direction

( d ) $\frac{10}{9}$ V/ μm and in the +ve x direction

6. In an AC circuit, the voltage applied is $E = E_0 \sin\omega t$. The resulting current in the circuit is $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The power consumption in the circuit is given by

(a) $P = \frac{E_0 I_0}{\sqrt{2}}$ (b) P = 0 (c) $P = \frac{E_0 I_0}{2}$ (d) $\sqrt{2}E_0 I_0$

7. A charged particle of mass m and charge q travels on a circular path of radius r that is perpendicular to a magnetic field B. The time taken by the particle to complete one revolution is
(a) 2πmq/ B (b) $2\pi q^2 B/m$ (c) 2πqB/ m (d) 2πm/qB

**8.** An air cored solenoid has 300 turns, its length is 25 cm and its cross section is 3 $cm^2$. The self-inductance in Henry (given that $\mu=4\pi \times 10^{-7}$).

(a) $5.1356\times10^{-3}$ (b) $0.1356\times10^{-5}$ (c) $0.1356\times10^{-3}$ (d) $5.1356\times10^{-5}$

**9.** In electromagnetic wave the phase difference between electric and magnetic field vector **E** and **B** in a perfectly dielectric medium is
(a) 0 (b) π/2. (c) π (d) 2π.

10. A sphere of radius $\sqrt{7}$ cm at 727℃ is suspended in a vacuum in an enclosure at 227℃. Find out the rate of loss of heat of the sphere assuming that it is a black body. Take $\sigma = 5.7 \times 10^{-8}$ W $m^{-2}$ $K^4$.

(a) 475 Watt (b) 470 Watt
(c) 465 Watt (d) 460 Watt

**11.** The *r.m.s* velocity of the molecule of a gas at 27℃ is $1.82 \times 10^3$ m/s. What will be the *r.m.s.* velocity at 127℃?

(a) $2.1 \times 10^4$ m/s (b) $2.1 \times 10^5$ m/s. (c) $22.1 \times 10^3$ m/s
(d) $2.1 \times 10^3$ m/s

**12.** When an unpolarized light of intensity $I_0$ is incident on a polarizing sheet, the intensity of the light which does not get transmitted is
(a) $I_0/2$ (b) $I_0/4$ (c)zero (d) $I_0$

13. The wave function of a particle at a given time is

$$\psi(x) = \begin{cases} \sqrt{\frac{2}{L}} \sin\frac{\pi x}{L} & \text{for } 0 < x < L \\ 0 & \text{otherwise} \end{cases}$$

Find the probability of finding the particle in the range $\frac{L}{4} < x < \frac{3L}{4}$ at this time.

(a) 0.82 (b) 0.52 (c) 0.72 (d) 0.92

14. Calculate the longest wavelength that can be analyzed by a rock salt crystal of spacing $d = 2.82$ Å in the first order?

(a) 2.82 Å (b) 5.64 Å (c) 1.88 Å (d) 8.86 Å

15. In intrinsic semiconductor, the Fermi level lies

(a) Near conduction band
(b) Near valence band
(c) At midway of energy gap
(d) None of these

1. Vaska's complex is

| | |
|---|---|
| A. six coordinate with Ir(III) | B. four coordinate with Ir(I) |
| C. four coordinate with Rh(I) | D. four coordinate with Rh(III) |

2. In diborane the B-H-B angles are about

| | |
|---|---|
| A. 100° | B. 90° |
| C. 93° | D. 83° |

3. In a commercial preparation dry heating of $Na_2CO_3$ with urea gives

| | |
|---|---|
| A. NaCN, $CO_2$ and $NH_3$ | B. NaOCN, $CO_2$ and $NH_3$ |
| C. NaCN, $CH_4$ and $NO_2$ | D. NaOCN, CO and $N_2H_4$ |

4. Arrange the following Lewis acids in the order of increasing softness

$Cu^+$, $Au^+$, $Ag^+$ and $K^+$

| | |
|---|---|
| A. $Au^+ < K^+ < Ag^+ < Cu^+$ | B. $K^+ < Ag^+ < Au^+ < Cu^+$ |
| C. $K^+ < Ag^+ < Cu^+ < Au^+$ | D. $K^+ < Cu^+ < Ag^+ < Au^+$ |

5. Electronic configuration of the central metal ion in the compound $[W(CO)_6]$ is

| | |
|---|---|
| A. $d^5$, $t_{2g}^5$, S=1/2 | B. $d^6$, $t_{2g}^6$, S=0 |
| C. $d^4$, $t_{2g}^4$, S=1 | D. $d^6$, $t_{2g}^4 e_g^2$, S=2 |

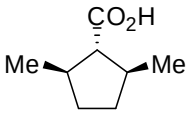
6. A solution of (-)-2-chloro-2-phenylethane in toluene racemises slowly in the presence of small amount of $SbCl_5$, due to the formation of

| | |
|---|---|
| A. Carbanion | B. Carbene |
| C. Free radical | D. Carbocation |

7. Which of the following alcohol will react faster with Lucas reagent at room temperature is

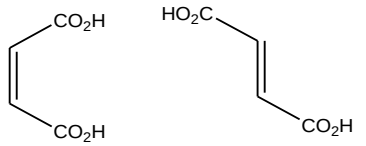
| | |
|---|---|
| A. Butan-1-ol | B. Butan-2-ol |
| C. 2-Methylpropan-1-ol | D. 2-Methylpropan-2-ol |

8. Which of the following statement is true about this molecule?




| | |
|---|---|
| A. Chiral | B. Achiral due to presence of plane of symmetry |
| C. It is racemic | D. Chiral but optically inactive |

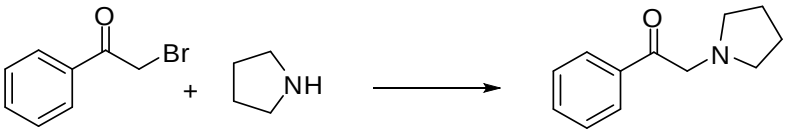
9. Which of the following statement is true about maleic acid and fumaric acid?




Maleic acid Fumaric acid

| | |
|---|---|
| A. Maleate mono anion is much more stabilized than fumarate mono anion. | B. Fumarate mono anion is much more stabilized than maleate mono anion. |
| C. Both the mono anions have same stability. | D. None of the above is true |

10. The following reaction follows a




| | |
|---|---|
| A. $S_N1$ pathway | B. $S_N2$ pathway |
| C. Mixed $S_N1$ and $S_N2$ pathway | D. None |

11. A vapor at 39 atm and 25 °C was allowed to expand adiabatically to a final pressure of 1.00 atm through a porous wall. Calculate the final temperature. The Joule–Thomson coefficient, $\mu$, at 25°C is 0.32 K $atm^{-1}$; assume that it remains constant over this temperature range.

| | |
|---|---|
| A. 13 °C | B. 18 °C |
| C. 28 °C | D. 30 °C |

**12.** Which one of the following is an extensive quantity?

| | |
|---|---|
| A. density | B. Heat capacity |
| C. pressure | D. specific heat capacity |

13. In the gas-phase reaction A + B ⇌ 2C + 3D, it was found that when 15.0 mol A, 18.0 mol B, were mixed and allowed to come to equilibrium at 600 K, the resulting mixture contained 10 mol C at a total pressure of 1 bar. What is the value of $K^0_p$ at 600 K

| | |
|---|---|
| A. 0.023 | B. 0.037 |
| C. 1.500 | D. 0.500 |

14. Given: E° ($Ag^{+}/Ag$) = 0.8 V at 298 K and E° ($Zn^{+2}/Zn$) = - 0.76 V at 298 K . An $AgNO_3$ solution containing a silver electrode is connected by means of a salt bridge to a $ZnCl_2$ solution containing a zinc electrode. Find the correct answer for the constructed cell at 298 K.

| | |
|---|---|
| A. Ag (anode), Zn (cathode), flow of electrons Ag→ Zn | B. Zn (anode), Ag (cathode), flow of electrons Ag → Zn |
| C. Zn (anode), Ag (cathode), flow of electrons Zn → Ag | D. Ag (anode), Zn (cathode), flow of electrons Zn → Ag |

15. Given the reactions (a) and (b) below, determine $\Delta H^{o}_{r}$ for reaction (c) at 298 K.

(a) $H_2(g) + Br_2(l) \rightarrow 2\ HBr(g)$ $\Delta H^{o}_{r}$ = - 72.80 kJ $mol^{-1}$ at 298 K

(b) $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$ $\Delta H^{o}_{r}$ = –483.64 kJ $mol^{-1}$ at 298 K

(c) $4\ HBr(g) + O_2(g) \rightarrow 2\ Br_2(l) + 2\ H_2O(g)$

| | |
|---|---|
| A. -338 kJ $mol^{-1}$ | B. 338 kJ $mol^{-1}$ |
| C. 243 kJ $mol^{-1}$ | D. -243 kJ $mol^{-1}$ |

1. If an equivalence relation $R$ on $A = \{1,2,3,4,5\}$ partitions $A$ as $\{1\} \cup \{2\} \cup \{3,4,5\}$ then total number of elements in $R$ is
   A. 3
   B. 6
   C. 8
   D. 11

2. Let $\mathbb{Z}$ be the set of all integers and for any integer $n > 1, H = \{0, \pm n, \pm 2n, \pm 3n, \dots\}$. Then total number of left cosets of $H$ in $(\mathbb{Z}, +)$ is
   A. 1
   B. $n$
   C. 2n
   D. infinity

3. Total number of elements $x$ in a integral domain $D$ which satisfy $x^2 = x$ is
   A. 2
   B. 1
   C. 0
   D. infinity

4. If $A$ and $B$ are symmetric matrices, then which of the following is certainly symmetric?
   A. $AB$
   B. $ABA$
   C. $(A + B)(A - B)$
   D. $ABAB$

5. Which of the following is true for the system: $2x - 2y + 3z + 4w = -1$,
   $-x + y + 2z + 5w = 2, -z - 2w = 3, x - y + 2z + 3w = 0.$
   A. consistent and has finite number of solutions
   B. consistent and has infinite number of solutions
   C. has unique solution.
   D. inconsistent

6. General solution of the differential equation $(x^2 - 4xy - 2y^2)dx + (y^2 - 4xy - 2x^2)dy = 0$ is
   A. $y^3 + 6xy^2 + 6x^2y + x^3 = c$
   B. $y^3 - 6xy^2 - 6x^2y + x^3 = c$
   C. $y^3 - 6xy^2 - 6x^2y - x^3 = c$
   D. $y^3 - 6xy^2 + 6x^2y - x^3 = c$

7. The differential equation $y \sin 2x\, dx - (1 + y^2 + \cos^2 x)dy = 0$ is
   A. exact
   B. not exact
   C. separable
   D. homogenous

8. General solution of the differential equation $\frac{d^2y}{dx^2} + 9\frac{dy}{dx} + 20y = 0$ is
   A. $y = c_1e^{-4x} + c_2e^{-5x}$
   B. $y = c_1e^{x} + c_2e^{-x}$
   C. $y = c_1e^{-4x} + c_2e^{5x}$
   D. $y = c_1e^{x} + c_2e^{-x}$
9. The value of $\lim_{x\to 1} \frac{2x-2}{\sqrt[3]{26+x}-3}$ is
   A. 1
   B. $\infty$
   C. 24
   D. 54

10. The function $f(x) = \frac{x^3+1}{x+1}$
    A. is continuous anywhere on the real line
    B. not continuous anywhere on the real line
    C. is discontinuous at $x = -1$ and is not a removable discontinuity
    D. has removable discontinuity at $x = -1$
11. Which of the following is an asymptote of the curve $= xe^{\frac{1}{x}}$ ?
    A. $y = x - 1$
    B. $y = x$
    C. $y = x + 1$
    D. $y = 2$
12. The value of $\int \ln\left(\sqrt{1-x} + \sqrt{1+x}\right)\, dx$ is
    A. $x\ \ln\left(\sqrt{1-x} + \sqrt{1+x}\right) + \frac{1}{2}\ x + \frac{1}{2}\sin^{-1}\mathrm{x} + \mathrm{c}$
    B. $x\ \ln\left(\sqrt{1-x} + \sqrt{1+x}\right) - \frac{1}{2}\ x + \frac{1}{2}\sin^{-1}\mathrm{x} + \mathrm{c}$
    C. $x\ \ln\left(\sqrt{1-x} + \sqrt{1+x}\right) + \frac{1}{2}\ x - \frac{1}{2}\sin^{-1}\mathrm{x} + \mathrm{c}$
    D. $x\ \ln\left(\sqrt{1-x} + \sqrt{1+x}\right) - \frac{1}{2}\ x - \frac{1}{2}\sin^{-1}\mathrm{x} + \mathrm{c}$
13. The area of the region bounded by the curves $y = (x-4)^2, y = 16 - x^2$ and the $x$-axis is
    A. $\frac{64}{3}$
    B. $\frac{32}{3}$
    C. $\frac{16}{3}$
    D. $\frac{8}{3}$
14. The directional derivative of $f = xyz$ at $P = (-1,1,3)$ in the direction of the vector $\vec{a} = \hat{\imath} - 2\hat{\jmath} + 2\hat{k}$ is
    A. $\frac{1}{3}$
    B. $\frac{5}{3}$
    C. $\frac{7}{3}$
    D. $\frac{10}{3}$

15. If $v = yz\hat{\imath} + 3zx\hat{\jmath} + z\hat{k}$ then curl $v$ with respect to right handed cartesian coordinates is
    A. $3x\hat{\imath} - y\hat{\jmath} + 2z\hat{k}$
    B. $-3x\hat{\imath} + y\hat{\jmath} - 2z\hat{k}$
    C. $-3x\hat{\imath} + y\hat{\jmath} + 2z\hat{k}$
    D. $3x\hat{\imath} + y\hat{\jmath} + 2z\hat{k}$

16. $\lim_{x\to 0} \frac{1-\cos x+\cos 2x}{x^2}$ is equal to
    A. 1
    B. $-1$
    C. 0
    D. 2

17. If $f(x,y) = \begin{cases} \frac{x^2-xy}{x+y}, & for\ (x,y) \neq (0,0) \\ 0, & for\ (x,y) = (0,0) \end{cases}$ then $f_y(0,0)$ is equal to
    A. 1
    B. 0
    C. $-1$
    D. does not exist

18. The function $xy - x^2 - y^2 - 2x - 2y$ has
    A. maximum at $(2,2)$
    B. minimum at $(2,2)$
    C. minimum at $(-2,-2)$
    D. maximum at $(-2,-2)$

19. Value of the beta function $B\left(\frac{1}{3},\frac{2}{3}\right)$ is equal to
    A. $\frac{2\pi}{\sqrt{3}}$
    B. $-\frac{2\pi}{\sqrt{3}}$
    C. $\frac{\pi}{\sqrt{3}}$
    D. $-\frac{\pi}{\sqrt{3}}$,

20. Which of the following sequences $\{a_n\}$ diverges ?
    A. $a_n = \left(\frac{3n+1}{3n-1}\right)^n$
    B. $a_n = \left(\frac{1}{3}\right)^n + \frac{1}{\sqrt{2^n}}$
    C. $a_n = \frac{n!}{10^{6n}}$
    D. $a_n = \frac{3^n 6^n}{2^{-n} n!}$

21. Laplace transform of $t^2 \cos t$ is equal to
    A. $\frac{2s^3-6s}{(s^2+1)^3}$
    B. $\frac{2s^3+6s}{(s^2+1)^3}$
    C. $\frac{2s^3-6s}{(s^2-1)^3}$
    D. $\frac{2s^3+6s}{(s^2-1)^3}$
22. If $L\left(\frac{d^2Y}{dt^2}\right) + L\left(\frac{dY}{dt}\right) = \frac{1}{s^2}$, where $L$ stands for Laplace transform, then which of the following values of y is true
    A. $y = L^{-1}\left(\frac{1}{s^2} + \frac{s+3}{s^2+1}\right)$
    B. $y = L^{-1}\left(\frac{1}{s^2} - \frac{s+3}{s^2+1}\right)$
    C. $y = L^{-1}\left(\frac{1}{s^2} + \frac{s-3}{s^2+1}\right)$
    D. $y = L^{-1}\left(\frac{1}{s^2} + \frac{s+3}{s^2-1}\right)$
23. Dimension of the vector space of all $3 \times 3$ real symmetric matrices with usual matrix addition and scalar multiplication, is
    A. 4
    B. 6
    C. 9
    D. 3
24. Inverse of the linear transformation $T(x, y) = (x + y, 2x - y)$ is
    A. $T^{-1}(u, v) = \frac{1}{3}(u - v, 2u - v)$
    B. $T^{-1}(u, v) = \frac{1}{3}(u - v, 2u + v)$
    C. $T^{-1}(u, v) = \frac{1}{3}(u + v, 2u - v)$
    D. $T^{-1}(u, v) = \frac{1}{3}(2u - v, u + v)$

25. Nullity of the linear transformation $T: \mathbb{R}^3 \to \mathbb{R}^2$ defined by $T(x, y, z) = (x + y, y + z)$ is
    A. 2
    B. 3
    C. 0
    D. 1
26. If $\{x_n\}$ is the sequence of Secant's iterates to compute $\sqrt[3]{7}$ if then $x_{n+1}$ is equal to
    A. $x_n x_{n-1}(x_n - x_{n-1}) - 7$
    B. $x_n x_{n-1}(x_n - x_{n-1}) + 7$
    C. $x_n x_{n-1}(x_n + x_{n-1}) + 7$
    D. $x_n x_{n-1}(x_n + x_{n-1}) - 7$

27. If $ax^2 + bx + c$ is the Lagrange polynomial which interpolates the data

| $x$ | 0 | 1 | -1 |
|---|---|---|---|
| $f(x)$ | 0 | 1 | 1 |

then $a + b + c$ is equal to

A. 0
B. 1
C. 2
D. 3

28. Value of $\int_0^1 \left(\int_0^1 \frac{x-y}{(x+y)^3} dy\right) dx$ is equal to

A. 1
B. 2
C. 0
D. $\frac{1}{2}$

29. Equation of the line passing through $(1,2,3)$ and parallel to the line, which is the intersection of the planes $x - y + 2z = 5, 3x + y + z = 6,$ is

A. $\frac{x-1}{-3} = \frac{y-2}{5} = \frac{z-3}{4}$
B. $\frac{x+1}{-3} = \frac{y+2}{5} = \frac{z-3}{4}$
C. $\frac{x-1}{3} = \frac{y-2}{5} = \frac{z-3}{4}$
D. $\frac{x+1}{3} = \frac{y+2}{5} = \frac{z=3}{4}$

30. If the chord of hyperbola $x^2 - y^2 = a^2$ touches the parabola $y^2 = 4ax$ then locus of their mid point is

A. $y^2(x + a) = x^3$
B. $y^2(a - x) = x^3$
C. $y^2(x - a) = x^3$
D. $x^2(x + a) = y^3$