Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34} \text{ J-s}$
Charge of electron	$e = 1.6 \times 10^{-19} \text{ C}$
Mass of electron	$m_e = 9.1 \times 10^{-31} \text{ kg}$
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	$6.625 \times 10^{-34} \text{ J·s}$
		=	$6.625 \times 10^{-27} \text{ erg·s}$
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	$1.66 \times 10^{-27} \text{ kg}$
1 eV		=	$1.6 \times 10^{-19} \text{ J}$

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35,   Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics   *PART – I*

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A solid cylinder rolling down an inclined plane (with angle of inclination θ) without slipping which of the following statement is incorrect?
    (A) the friction force is dissipative
    (B) the friction force will aid rotation
    (C) the friction force will hinder translation
    (D) the friction force will change if θ is changed

2. The following field line does not represent any of the two fields given in which option?
    (A) Induced electric field and electrostatic field
    (B) Magneto static field and induced electric field
    (C) Gravitational field of a mass at rest and electrostatic field
    (D) Magneto static field and Gravitational field of a mass at rest
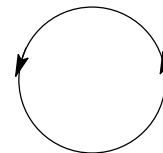
3. A particle is projected from ground at angle θ with horizontal, in such a way that a does not recede towards the point of projection. The maximum value of $\sin \theta$?

    (A) $2\dfrac{\sqrt{2}}{3}$

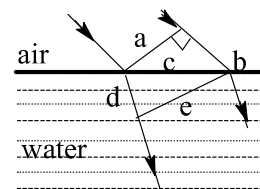   (B) $\dfrac{\sqrt{2}}{3}$

    (C) $\dfrac{\sqrt{3}}{2}$

    (D) this is not possible

4. Figure shown plane waves refracted for air to water using Huygen's principle a, b, c, d, e are lengths on the diagram. The refractive index of water w.r.t air is the ratio.
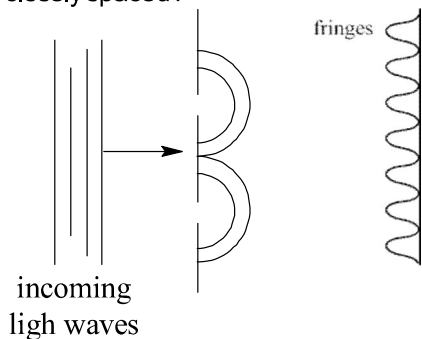   (A) a/e   (B) b/e
   (C) b/d   (D) d/b

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Space for rough work

5. In a Young's double slit experiment, green light is incident on the two slits. The interference pattern is observed on a screen. Which of the following changes would cause the observed fringes to be more closely spaced?

fringes

incoming
ligh waves

(A) Reducing the separation between the slits
(B) Using blue light instead of green light
(C) Used red light instead of green light
(D) Moving the light source further away from the slits.

6. A wire loop is placed in a region of time varying magnetic field which is oriented orthogonally to the plane of the loop as shown in the figure. The graph shows the magnetic field variation as the function of time. Assume the positive emf is the one which drives a current in the clockwise direction and seen by the observer in the direction of B. Which of the following graphs best represents the induced emf as a function of time.
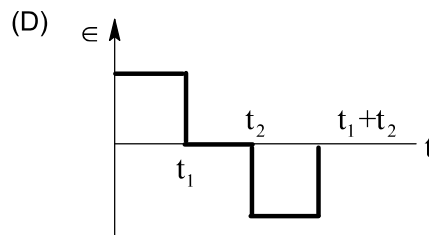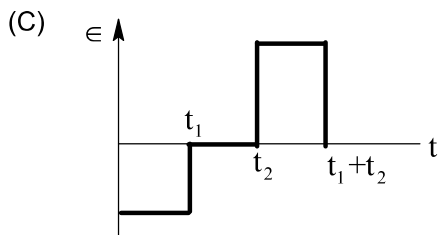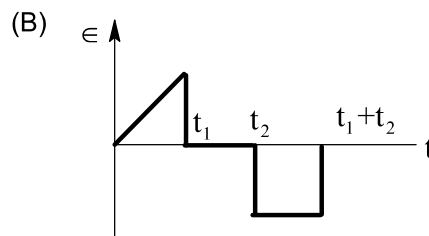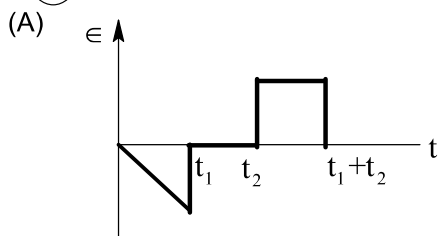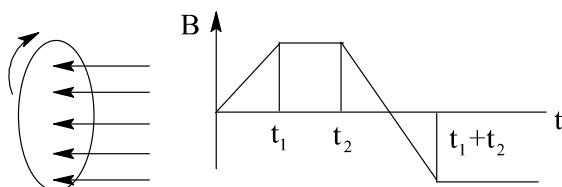
7. A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge +Q is now given to its positive plate. The potential difference across the capacitor is now:

(A) V

(B) $V + \dfrac{Q}{C}$

(C) $V + \dfrac{Q}{2C}$

(D) $V - \dfrac{Q}{C}, if\ V < CV$

8. An infinite number of concentric rings carry a charge Q each alternately positive and negative. Their radii 1,2,4,8....meters in geometric progression as shown in the figure. The potential at the centre of the ring will be.
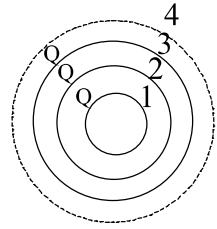
(A) Zero

(B) $\dfrac{Q}{12\pi\varepsilon_0}$

(C) $\dfrac{Q}{8\pi\varepsilon_0}$

(D) $\dfrac{Q}{6\pi\varepsilon_0}$

9. Select the correct choice:
(A) The gravitational field inside a spherical cavity, within a spherical planet must be non zero and uniform.
(B) When a body is projected horizontally at an appreciable large height above the earth, with a velocity less than for a circular orbit, it will fall to the earth along a parabolic path.
(C) A body of zero total mechanical energy placed in a gravitational field will escape the field
(D) Earth's satellite must be in equatorial plane.

10. The rate of emission of radiation of a black body at 273°C is E, then the rate of emission of radiation of this body at 0°C will be:

(A) $\dfrac{E}{16}$

(B) $\dfrac{E}{4}$

(C) $\dfrac{E}{8}$

(D) 0

11. A sphere of ice at 0°C having initial radius R is placed in an environment having ambient temperature > 0°C. The ice melts uniformly, such that shape remains spherical. After a time 't' the radius of the sphere has reduced to r. Assuming the rate of heat absorption is proportional to the surface area of the sphere at any moment, which graph best depicts r (t).

(A)

(B)

(C)

(D)
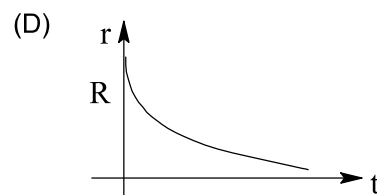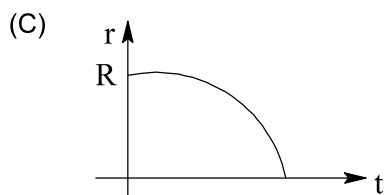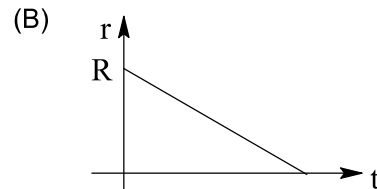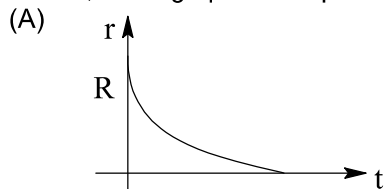
Space for rough work

12. If angular velocity of a disc depends an angle rotated θ as $\omega = \theta^2 + 2\theta$, then its angular acceleration α at $\theta = 1$ rad is :
(A) 8 rad/sec^2 (B) 10 rad/sec^2
(C) 12 rad/sec^2 (D) None

13. Two projectiles are thrown simultaneously in the same plane from the same point. If their velocities are v_1 and v_2 at angles θ_1 and θ_2 respectively from the horizontal. Then the trajectory of particle 1 with respect to particle 2 will be
(A) a parabola because both move in parabolic path.
(B) a straight line because both move in parabolic path
(C) a parabola because both move with same acceleration.
(D) a straight line because both move with same acceleration.

14. Which of the following statements is true for a particle moving in a circle with a constant angular speed?
(A) the velocity vector is normal to the circle.
(B) the acceleration vector is tangent to the circle.
(C) the acceleration vector points to the centre of the circle
(D) the velocity and acceleration vectors are parallel to each other

15 Three noncollinear vectors $\vec{a}, \vec{b}\ \&\ \vec{c}$ are coplanar then which of the following is incorrect:

(A) $\vec{a}.\left(\vec{b}\times\vec{c}\right)=0$

(B) $\left(\vec{b}\times\vec{a}\right).\vec{c}=0$

(C) $\left(\vec{b}\times\vec{a}\right)\times\vec{c}=0$

(D) $\vec{a}=k\,\vec{b}+m\vec{c}$ where k & m are two real numbers

Space for rough work

16. The acceleration-time (a-t) curves for two bodies A and B starting from rest are shown in the figure. Body A achieves maximum velocity V_m and body B achieves maximum velocity $V_m/2$. Find the value of time t in terms of a_1 and a_2:
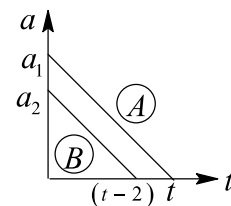
(A) $\dfrac{4a_2}{\left(2a_2 - a_1\right)}$

(B) $\dfrac{4a_2}{\left(a_2 - a_1\right)}$

(C) $\dfrac{a_2}{\left(2a_2 - a_1\right)}$

(D) $\dfrac{2a_2}{\left(a_2 - a_1\right)}$

17. The average total energy density of the electromagnetic wave is, if the rms value of the electric field of the light coming from the sun is $500\,NC^{-1}$. :

(A) $4\times10^{-6}\,Jm^{-3}$

(B) $3.7\times10^{-19}\,Jm^{-3}$

(C) $1.35\times10^{-12}\,Jm^{-3}$

(D) None of these

18. A rod is supported horizontally by means of two strings of equal length as shown in figure. If one of the string is cut. Then tension in other string at the same instant will:
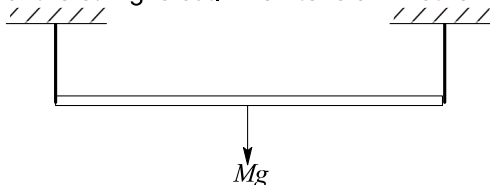
(A) remain unaffected

(B) increase

(C) decreases

(D) become equal to weight of the rod

19. A uniform circular ring rolls without slipping on a horizontal surface. At any instant, its position is as shown in the figure. Then mark the incorrect option:
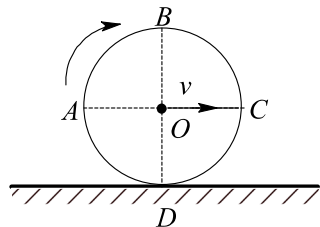
(A) Section ABC has greater kinetic energy than section ADC

(B) Section BC has greater kinetic energy than section CD

(C) Section BC has the same kinetic energy as section DA

(D) None of these

20. A plane wave of sound travelling in air is incident upon a plane water surface. The angle of incidence is 60°. If velocity of sound in air and water are 330 m/s and 1400 m/s, then the wave undergoes:

(A) refraction only

(B) reflection only

(C) both reflection and refraction

(D) neither reflection nor refraction

Chemistry

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Most soluble hydroxide in benzene is:
    (A) $LiOH$ (B) $NaOH$
    (C) KOH (D) $RbOH$

2. Referring to figure-1, identify the three spots obtained by electrophoresis at $p^H = 7$ of a mixture of the proteins pepsin $\left(p^I = 1.1 \right)$ haemoglobin $\left(p^I = 6.8 \right)$ and Lysozyme $\left(p^I = 11.0 \right)$:

    Start

    $\left(+ \right)$ electrode | •   •   • | $\left(- \right)$ electrode
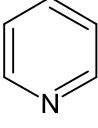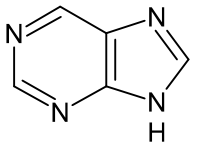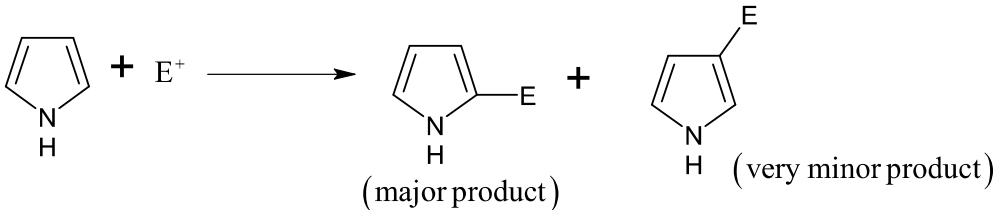   A   B   C
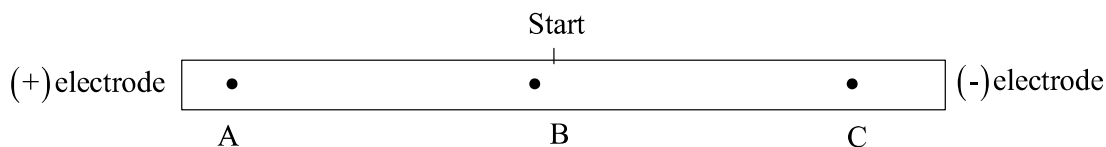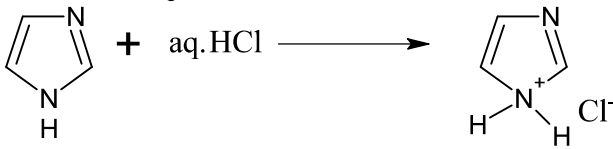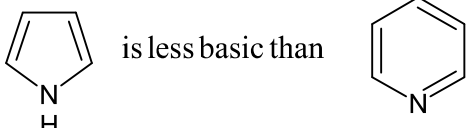
    Fig-1

    Which of the following options are correct about position of various proteins?
    (A) Lysozyme will be present at spot A   (B) pepsin will be present at spot B
    (C) pepsin will be present at spot A   (D) haemoglobin will be present at spot C
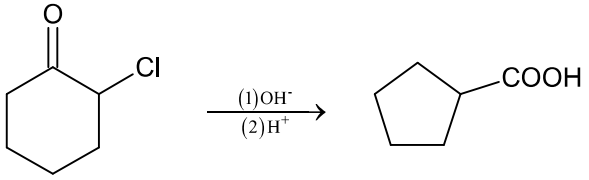
3. Silver sulphide dissolves in sodium cyanide solution to form the complex?
    (A) $Na_2 \left[Ag \left(CN \right)_4 \right]$ (B) $Na \left[Ag \left(CN \right)_2 \right]$
    (C) $Na_3 \left[Ag \left(CN \right)_4 \right]$ (D) $Na_3 \left[Ag \left(CN \right) \right]$

Space for rough work

4. Which of the following is incorrect statement/reaction?

(A)

   + aq. HCl $\longrightarrow$

(B)

 is less basic than

(C)

 purine has 3 N's as basic sites

(D)

 + E^+ $\longrightarrow$ (major product) + (very minor product)

5. Which of the following statement is wrong about complex anion $\left[Co(EDTA)\right]^-$?

(A) oxidation state of Co is $+3$

(B) compound is optically active

(C) number of Co rings is 4

(D) total number of five member rings is 6
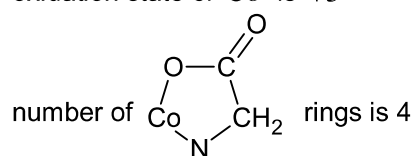
6. Which of the following reaction is incorrect?

(A)

$Ph-CH_2-\overset{\overset{\displaystyle O}{||}}{C}-CH_2-Cl$ $\xrightarrow[(2)H^+]{(1)OH^-}$ $Ph\text{-}CH_2CH_2COOH$

(B)

$Ph-\underset{\underset{\displaystyle Cl}{|}}{CH}-\overset{\overset{\displaystyle O}{||}}{C}-CH_3$ $\xrightarrow[(2)H^+]{(1)OH^-}$ $Ph\text{-}CH_2CH_2COOH$

(C)

 $\xrightarrow[(2)H^+]{(1)OH^-}$

(D)

$Ph-CH_2-CH_2-\overset{\overset{\displaystyle O}{||}}{C}-Cl$ $\xrightarrow[(2)H^+]{(1)OH^-}$

7. What will be the ratio of volumes of $2M\ FeSO_4$ and $3M\ \ KMnO_4$ in acidic medium for oxidation of Fe^{2+} solution?

(A) $\dfrac{2}{9}$ (B) $\dfrac{15}{2}$

(C) $\dfrac{2}{15}$ (D) $\dfrac{9}{2}$

8. Which of the following reaction can be used for preparation of alcohol from carbonyl compound

(A) $\xrightarrow{\text{NaBH}_4}$

(B) $\xrightarrow{\text{LiAlH}_4}$

(C) $\xrightarrow{\text{NaBH}_4}$

(D) $\xrightarrow{\text{LiAlH}_4}$
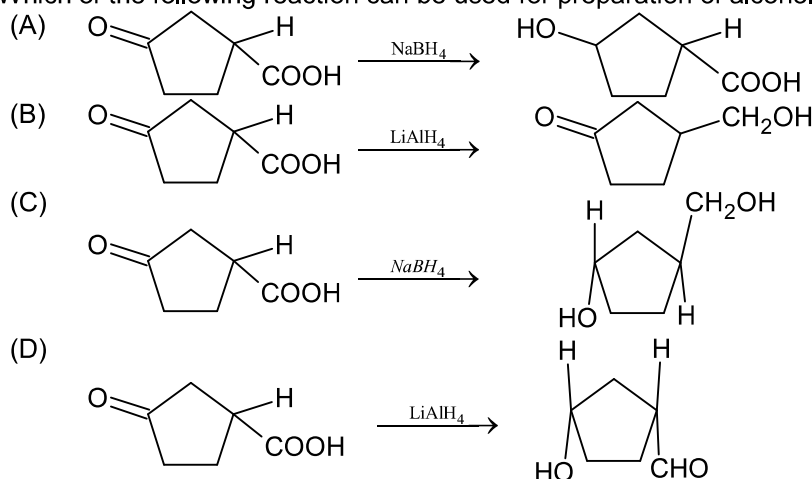
9. Which of the following molecules/ions are attracted by an externally applied magnetic field?

(A) $O_2,\ NO,\ N_2^{2+},\ B_2,\ C_2^{2+}$ (B) $O_2^{+},\ NO,\ N_2^{+},\ C_2^{2+},\ B_2$

(C) $N_2^{2-},\ N_2^{2+},\ C_2^{2-},\ B_2^{2+},\ O_2^{2+}$ (D) $O_2^{+},\ N_2^{-},\ B_2^{2-},\ NO,\ C_2^{2-}$

10. When phenyl benzoate ($PhOCOPh$) undergoes electrophilic substitution, which of the following indicates the site for attack of electrophile as major product?

(A)   (B)

(C)   (D)
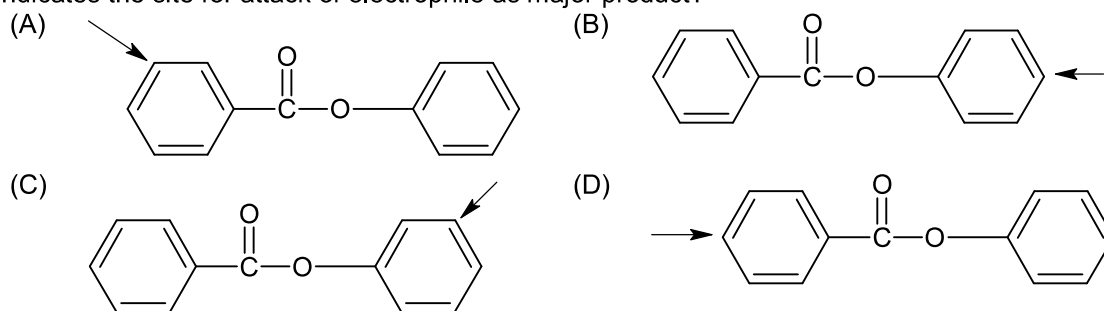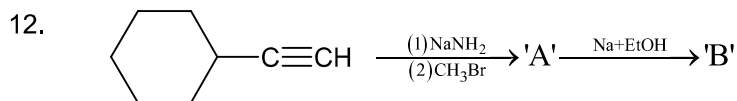

Space for rough work

11. Which of the following statement about diffusion of gas is true?
(A) Rate of diffusion of a gas will increase if an inert gas is added to gaseous mixture and allowed to diffuse through a pin hole
(B) Rate of effusion of O_2 is $\sqrt{2}$ times that of SO_2, for every composition of O_2 and SO_2 mixture
(C) Rate of effusion decrease on increasing the temperature
(D) All are true.

12.

(A) 'A' is

(B) 'B' is
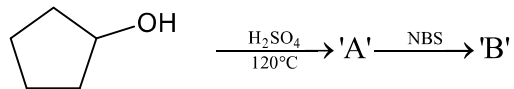

(C) 'A' is

(D) 'B' is
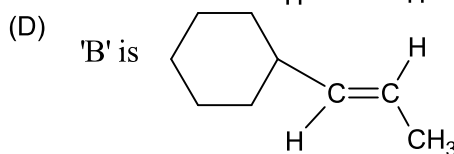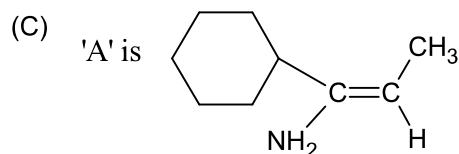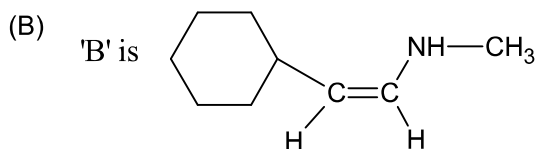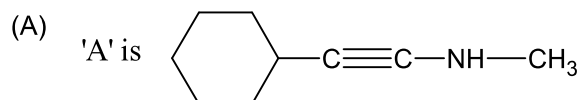
13. Which of the following redox reaction is balanced redox reaction?
(A) $IO_3^- + SO_3^{2-} + 4H^+ \longrightarrow I^- + SO_4^{2-} + 2H_2O$
(B) $2BaO + O_2 \longrightarrow 2BaO_2$
(C) $2I^- + 2IO_3^- \longrightarrow 2I_2 + 3O_2$
(D) $MnO_4^- + C_2O_4^{2-} + 8H^+ \longrightarrow M_n^{2+} + 2CO_2 + 4H_2O$

Space for rough work

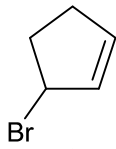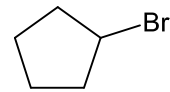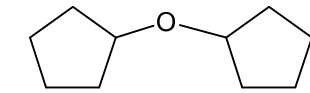**14.**

(A) 'B' is

(B) 'B' is
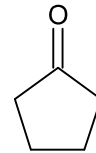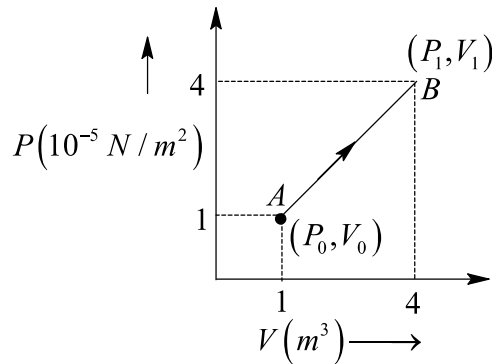
(C) 'A' is

(D) 'A' is

15.

The work done in changing state from A to B in following system is………

(A) $-7.5 \times 10^{-5} J$

(B) $-7.5 \times 10^{5} J$

(C) $+7.5 \times 10^{-5} J$

(D) $+7.5 \times 10^{5} J$

Space for rough work

16. $P_4 + HNO_3 \longrightarrow H_3PO_4 + NO_2 \uparrow + H_2O$
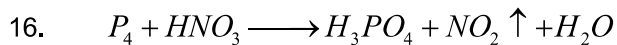
Product mixture is titrated with $0.1M$ $NaOH$, indicator shows colour change at second end point and $100ml$ of $NaOH$ is used for that. How much volume of $1M$ HNO_3 is used is above reaction?

(A) $20ml$

(B) $10ml$

(C) $25ml$

(D) $\dfrac{50}{3}ml$

17. When Lithium di-(3-pentyl) cuprate reacts with ethyl bromide produces:
(A) heptane
(B) triethyl methane
(C) 2-ethylpentane
(D) 3-methyl hexane

18. 2, 7-Octanedione on treatment with aq. KOH and 100°C produces?

(A)
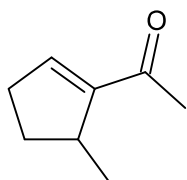
(B)
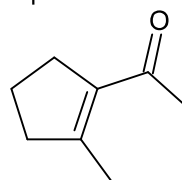
(C)
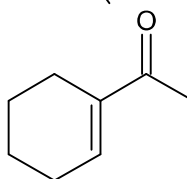
(D)
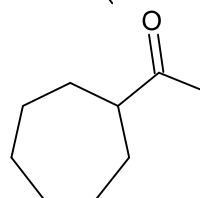
19. Which of the following salts are soluble in NH₄OH?
(A) CuSO₄
(B) AlCl₃
(C) FeCl₃
(D) all of the above

20. Zinc on reaction with NaOH gives a salt (A) along with a gas (X) and (A) on reaction with a gas H_2S gives white precipitate (W). Which of the following is correct?
(A) (A) is Na₄ZnO₃, (Y) is H₂S
(B) (X) is H₂, (W) is Zn (OH)₂
(C) (A) is Na₂ZnO₂, (X) is O₂
(D) (W) is ZnS, (X) is H₂

Space for rough work

Mathematics

SECTION – A

Straight Objective Type

1. $\int \dfrac{3x^2 + 4x - 1}{\left(x^2 + 1\right)^2 \sqrt{x+1}} dx$ is equal to:

    (A) $\dfrac{\sqrt{x+1}}{x^2 + 1} + c$

    (B) $-\dfrac{2\sqrt{x+1}}{x^2 + 1} + c$

    (C) $\dfrac{2}{\left(x^2 + 1\right)\sqrt{x+1}}$

    (D) $\dfrac{-x}{\left(x^2 + 1\right)\sqrt{x+1}} + c$

2. The general solution of the differential $y\left(xy - \left(x^2 - y^2\right)^2\right) dx = \left\{ y^3 - x\left(x^2 - y^2\right)^2 \right\} dy$ is:

    (A) $\dfrac{y}{x} + \dfrac{1}{x^2 - y^2} = c$

    (B) $\dfrac{x}{y} - \dfrac{1}{2}\ln\left|\dfrac{x - y}{x + y}\right| = c$

    (C) $\dfrac{2x}{y} + \dfrac{1}{x^2 - y^2} = c$

    (D) $\dfrac{2x}{y} - \dfrac{1}{x^2 - y^2} = c$

3. A line is drawn at an angle θ with positive direction of x-axis. It intersects the parabola $y^2 = 8x$ at A and B. If AB is a normal chord which subtend a right angle at the vertex of the parabola, then $\tan^2 \theta$ equals:

    (A) $\dfrac{1}{2}$

    (B) $\dfrac{3}{4}$

    (C) 1

    (D) 2

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4. The equation of a circle whose diameter is the common chord of the circle
$x^2 + y^2 - 4x - 8y - 5 = 0$ and $x^2 + y^2 - 12x + 2y + 29 = 0$ is:
(A) $41x^2 + 41y^2 - 396x - 38y + 781 = 0$
(B) $2x^2 + 2y^2 - 16x - 6y + 25 = 0$
(C) $41x^2 + 41y^2 + 396x - 38y - 781 = 0$
(D) $17x^2 + 17y^2 - 300x + 154y + 901 = 0$

5. $\int_0^{\frac{11\pi}{3}} \sqrt{1 + \cos 2x}\, dx$ is equal to:

(A) $\dfrac{11\sqrt{3}}{2}$

(B) $8\sqrt{2} - \sqrt{\dfrac{3}{2}}$

(C) $8\sqrt{2} - \dfrac{\sqrt{3}}{2}$

(D) $\dfrac{22}{3}$

6. Consider the vectors $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = 3\hat{i} - \hat{j} + \hat{k}$. A parallelogram is constructed such that its diagonal are along $2\vec{a} - \vec{b}$ and $\vec{a} - 2\vec{b}$. The area of the parallelogram is:

(A) $9\sqrt{5}\ sq.units$

(B) $\dfrac{9\sqrt{10}}{2}\ sq.units$

(C) $9\sqrt{10}\ sq.units$

(D) $18\sqrt{5}\ sq.units$

7. Let $\dfrac{\tan\left(\dfrac{\pi}{4} + \alpha\right)}{5} = \dfrac{\tan\left(\dfrac{\pi}{4} + \beta\right)}{3} = \dfrac{\tan\left(\dfrac{\pi}{4} + \gamma\right)}{2}$. Then
$12\sin^2(\alpha - \beta) + 15\sin^2(\beta - \gamma) - 7\sin^2(\gamma - \alpha)$ is equal to:

(A) $-\dfrac{1}{2}$

(B) $\dfrac{1}{2}$

(C) 1

(D) 0

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8. The angle of intersection of the curves $y = (1+x)^{\cos x} + \sin x$ and $y = \dfrac{1}{2}(x^2 + x + 2)$ at (h, k) where h and k are integers, is θ, then $\tan \theta$ equals:

(A) $\dfrac{3}{4}$

(B) $\dfrac{4}{3}$

(C) 1

(D) 0

9. A plane $2x + 3y + 6z = 12$ intersects the x-axis, y-axis and z-axis at A, B, C respectively. The orthocentre of the triangle ABC is:

(A) $\left(\dfrac{24}{49}, \dfrac{36}{49}, \dfrac{72}{49}\right)$

(B) $\left(\dfrac{36}{49}, \dfrac{72}{49}, \dfrac{27}{49}\right)$

(C) $\left(\dfrac{24}{49}, \dfrac{16}{49}, \dfrac{1}{49}\right)$

(D) $\left(\dfrac{36}{49}, \dfrac{72}{49}, \dfrac{24}{49}\right)$

10. The domain of the function given by $f(x) = \log_3\left(\log_{\frac{1}{2}}\left(\log_2\left(\log_{\frac{1}{3}}(x)\right)\right)\right) + \dfrac{x+1}{\sqrt{1-3x-4x^2}}$ is:

(A) $\left(-1, \dfrac{1}{3}\right)$

(B) $\left(\dfrac{1}{4}, \dfrac{1}{3}\right)$

(C) $\left(\dfrac{1}{9}, \dfrac{1}{4}\right)$

(D) $\left(\dfrac{1}{9}, \dfrac{1}{3}\right)$

11. If $f(x) = \dfrac{3^{x-3}}{3^{1-x} + 3^x}$ for all $x \in Q$, then the value of

$f\left(\dfrac{1}{109}\right) + f\left(\dfrac{2}{109}\right) + f\left(\dfrac{3}{109}\right) + ... + f\left(\dfrac{108}{109}\right)$ is:

(A) 54

(B) 55

(C) 108

(D) 2

Space for rough work

12. The value of $\cot \displaystyle\sum_{n=1}^{\infty} \cot^{-1}\left(\dfrac{2}{n^2}\displaystyle\sum_{k=1}^{n} k^3\right)$

(A) $\dfrac{1}{2}$ (B) $\dfrac{1}{4}$

(C) $\dfrac{1}{3}$ (D) $\dfrac{1}{6}$

13. The graph of the function $y = f(x)$ has a unique tangent at $\left(\pi^a, 0\right)$. If

$$A = \lim_{x \to \pi^a} \frac{\ln\left(1 + 9f(x)\right) - \sin f(x)}{2f(x)}, \text{ then } \sum_{n=1}^{\infty} A^{-n} \text{ is equal to:}$$

(A) $\dfrac{1}{3}$ (B) $\dfrac{1}{2}$

(C) 4   (D) $\dfrac{1}{4}$

14. Let f be a continuous and differentiable function in (a,b), if $f(x).f'(x) \geq x\sqrt{1 - \left(f(x)\right)^4}$ and

$\lim_{x \to a^+} \left(f(x)\right)^2 = 1$ and $\lim_{x \to b^-} \left(f(x)\right)^2 = \dfrac{1}{2}$. Then the minimum value of $\left[a^2 - b^2\right]$

is $\left([.] \to \text{represent greatest integer function}\right)$:

(A) 1   (B) 9

(C) 3   (D) 81

15. The chord of contact of tangents drawn from any point on the circle $x^2 + y^2 = p^2$ to the circle $x^2 + y^2 = q^2$ touches the circle $x^2 + y^2 = r^2$, then $2a - \log_e p, 4a - \log_e q, 6a - \log_e r$ are in (a is real value):

(A) AP   (B) GP

(C) HP   (D) AGP

Space for rough work

16. If t_1, t_2 and t_3 are distinct, the points $\left(t_1, 2at_1 + at_1^3\right), \left(t_2, 2at_2 + at_2^3\right)$ and $\left(t_3, 2at_3 + at_3^3\right)$ are collinear, then $\dfrac{4^{t_1}.6^{t_2}.8^{t_3}}{2^{t_1}.3^{t_2}.4^{t_3}}$ is equal to:

(A) 0   (B) 4

(C) 2   (D) 1

17. The area of the triangle formed by the line $x + y = 2$ and angle bisectors of the pair of straight lines $x^2 - y^2 + 2y = 1$ is a and coordinate of orthocentre of triangle is (b, c), then $4a + b + c$ is equal to:

(A) 0   (B) 4

(C) 2   (D) 3

18. If z is the complex 5th root of unity, then $\dfrac{z^4}{z^4 + 1} + \dfrac{z}{1 + z} + \dfrac{z^2}{z^2 + 1} + \dfrac{z^4}{z + z^4}$ is:

(A) 2   (B) 0

(C) 4   (D) 1

19. If a tangent of slope 3 of the ellipse $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$ is normal to the circle $x^2 + y^2 + 4x + 1 = 0$ then the maximum value of ab is:

(A) 2   (B) 3

(C) 4   (D) 6

20. If $F(x) = \int_0^x f(t).dt$ and $F(x^2) = x^2(1 + x)$, then value of $f(4) = n$. Then unit place of $(985697)^{n^2}$ is:

(A) 3   (B) 7

(C) 1   (D) 9

Space for rough work