Joint Entrance Exam | Mains-2019

Paper Code -

10th April 2019 | Morning

PHYSICS , CHMISTRY & MATHEMATICS

Important Instructions:

1. Immediately fill in the particulars on this page of the Test Booklet with only Black Ball Point Pen provided in the examination hall.

2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.

3. The test is of **3 hours** duration.

4. The Test Booklet consists of **90** questions. The maximum marks are **360**.

5. There are three parts in the question paper A, B, C consisting of **Physics, Mathematics** and **Chemistry** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for correct response.

6. Candidate will be awarded marks as stated above in instruction No. 5 for correct response of each question. $\frac{1}{4}$ (one-fourth) marks of the total marks allotted to the questions (i.e. 1 mark) will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

7. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.

8. For writing particulars/marking responses on *Side-1* and *Side-2* of the Answer Sheet use ***only Black Ball Point Pen*** provided in the examination hall.

9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination room/hall.

10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in **four** pages (Page **20-23**) at the end of the booklet.

11. On completion of the test, the candidate must hand over the Answer Sheet to the **Invigilator** on duty in the Room/Hall. ***However, the candidates are allowed to take away this Test Booklet with them.***

12. The CODE for this Booklet is **B.** Make sure that the CODE printed on Side-2 of the Answer Sheet is same as that on this Booklet. Also tally the serial number of the Test Booklet and Answer Sheet are the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.

13. **Do not fold or make any stray mark on the Answer Sheet.**

Joint Entrance Exam/IITJEE-2019

PART-A	PHYSICS

1. Given below in the left column are different modes of communication using the kinds of waves given in the right column.

A.	Optical Fibre Communication	P.	Ultrasound
B.	Radar	Q.	Infrared Light
C.	Sonar	R.	Microwaves
D.	Mobile Phones	S.	Radio Waves

From the options given below, find the most appropriate match between entries in the left and the right column.

(1) A-R, B-P, C-S, D-Q **(2)** A-Q, B-S, C-P, D-R

(3) A-Q, B-S, C-R, D-P **(4)** A-S, B-Q, C-R, D-P

2. A proton, an electron, and a Helium nucleus, have the same energy. They are in circular orbits in a plane due to magnetic field perpendicular to the plane. Let r_p, r_e and r_{He} be their respective radii, then,

(1) $r_e > r_p > r_{He}$ **(2)** $r_e < r_p < r_{He}$ **(3)** $r_e > r_p = r_{He}$ **(4)** $r_e < r_p = r_{He}$

3. A stationary source emits sound waves of frequency 500 Hz. Two observers moving along a line passing through the source detect sound to be of frequencies 480 Hz and 530 Hz. Their respective speeds are in ms^{-1}, (Given speed of sound $= 300\, m/s$)

(1) 8,18 **(2)** 16,14 **(3)** 12,18 **(4)** 12,16

4. The electric field of a plane electromagnetic wave is given by $\vec{E} = E_0 \hat{i} \cos(kz)\cos(\omega t)$

The corresponding magnetic field $\vec{B}$ is then given by:

(1) $\vec{B} = \frac{E_0}{C}\hat{j}\sin(kz)\sin(\omega t)$ **(2)** $\vec{B} = \frac{E_0}{C}\hat{j}\sin(kz)\cos(\omega t)$

(3) $\vec{B} = \frac{E_0}{C}\hat{j}\sin(kz)\cos(\omega t)$ **(4)** $\vec{B} = \frac{E_0}{C}\hat{j}\cos(kz)\sin(\omega t)$

5. A thin disc of mass *M* and radius *R* has mass per unit area $\sigma(r) = kr^2$ where r is the distance from its centre. Its moment of inertia about an axis going through its centre of mass and perpendicular to its plane is:

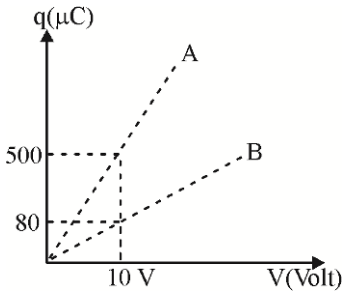
(1) $\frac{MR^2}{3}$ **(2)** $\frac{2MR^2}{3}$ **(3)** $\frac{MR^2}{6}$ **(4)** $\frac{MR^2}{2}$

6. A uniformly charged ring of radius 3a and total charge *q* is placed in *xy*-plane centred at origin. A point charge *q* is moving towards the ring along the *z*-axis and has speed *v* at $z = 4a$. The minimum value of v such that it crosses the origin is:

(1) $\sqrt{\frac{2}{m}}\left(\frac{1}{15}\frac{q^2}{4\pi \in_0 a}\right)^{1/2}$ **(2)** $\sqrt{\frac{2}{m}}\left(\frac{2}{15}\frac{q^2}{4\pi \in_0 a}\right)^{1/2}$

(3) $\sqrt{\frac{2}{m}}\left(\frac{4}{15}\frac{q^2}{4\pi \in_0 a}\right)^{1/2}$ **(4)** $\sqrt{\frac{2}{m}}\left(\frac{1}{5}\frac{q^2}{4\pi \in_0 a}\right)^{1/2}$

7. Figure shows charge (q) versus voltage (V) graph for series and parallel combination to two given capacitors. The capacitances are:



(1) $20\mu F$ and $30\mu F$

(2) $40\mu F$ and $10\mu F$

(3) $60\mu F$ and $40\mu F$

(4) $50\mu F$ and $30\mu F$

8. A cylinder with fixed capacity of 67.2 lit contains helium gas at STP. The amount of heat needed to raise the temperature of the gas by 20°C is : [Given that $R = 8.31 Jmol^{-1}K^{-1}$]

(1) 350 J **(2)** 374 J **(3)** 748 J **(4)** 700 J

9. Two radioactive materials A and B have decay constants 10λ and λ, respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of A to that of B will be $1/e$ after a time:

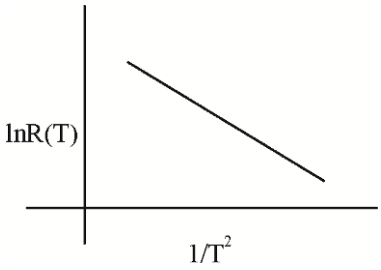
(1) $\frac{1}{9\lambda}$ **(2)** $\frac{1}{11\lambda}$ **(3)** $\frac{11}{10\lambda}$ **(4)** $\frac{1}{10\lambda}$

10. A ball is thrown upward with an initial velocity V_0 from the surface of the earth. The motion of the ball is affected by a drag force equal to $m\gamma v^2$ (where m is mass of the ball, v is its instantaneous velocity and γ is a constant). Time taken by the ball to rise to its zenith is:

(1) $\frac{1}{\sqrt{\gamma g}} sin^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$ **(2)** $\frac{1}{\sqrt{\gamma g}} tan^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

(3) $\frac{1}{\sqrt{2\gamma g}} tan^{-1}\left(\sqrt{\frac{2\gamma}{g}}V_0\right)$ **(4)** $\frac{1}{\sqrt{\gamma g}} ln^{-1}\left(1+\sqrt{\frac{\gamma}{g}}V_0\right)$

11. In an experiment, the resistance of a material is plotted as a function of temperature (in some range). As shown in the figure, it is a straight line, One may conclude that:



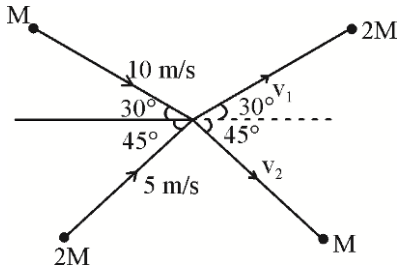
(1) $R(T) = R_0 e^{-T^2/T_0^2}$

(2) $R(T) = \frac{R_0}{T^2}$

(3) $R(T) = R_0 e^{-\frac{T_0^2}{T^2}}$

(4) $R(T) = R_0 e^{T^2/T_0^2}$

12. Two particles, of masses M and $2M$, moving, as shown, with speeds of 10 m/s and 5 m/s, collide elastically at the origin. After the collision, they move along the indicated directions with speeds v_1 and v_2, respectively. The values of v_1 and v_2 are nearly:



(1) $6.5 m/s$ and $6.3 m/s$

(2) $3.2 m/s$ and $6.3 m/s$

(3) $3.2 m/s$ and $12.6 m/s$

(4) $6.5 m/s$ and $3.2 m/s$

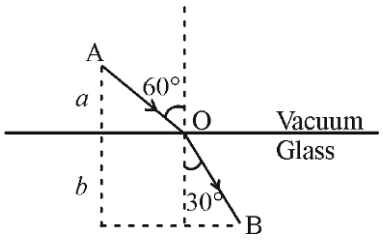
13. A current of $5A$ passes through a coper conductor (resistivity $=1.7\times10^{-8}\,\Omega m$) of radius of cross-section 5 mm. Find the mobility of the charges if their drift velocity is $1.1\times10^{-3}\,m/s$.

(1) $1.0\,m^2/Vs$ **(2)** $1.3\,m^2/Vs$ **(3)** $1.5\,m^2/Vs$ **(4)** $1.8\,m^2/Vs$

14. A transformer consisting of 300 turns in the primary and 150 turns in the secondary gives output power of 2.2 kw. If the current in the secondary coil is 10 A, then the input voltage and current in the primary coil are:

(1) 440 V and 5A **(2)** 220 V and 10 A
(3) 440 V and 20A **(4)** 220 V and 20 A

15. A ray of light AO in vacuum is incident on a glass slab at angle 60° and refracted at angle 30° along OB as shown in the figure. The optical path length of light ray from A to B is:



(1) $2a+\dfrac{2b}{3}$ **(2)** $\dfrac{2\sqrt{3}}{a}+2b$

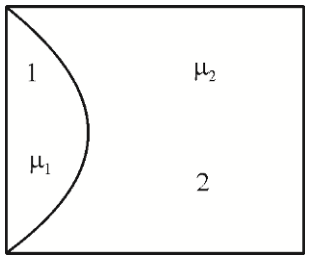
(3) $2a+2b$ **(4)** $2a+\dfrac{2b}{\sqrt{3}}$

16. In a photoelectric effect experiment the threshold wavelength of light is 380 nm. If the wavelength of incident light is 260 nm, the maximum kinetic energy of emitted electrons will be

Given E (in eV) $=\dfrac{1237}{\lambda(in\,nm)}$

(1) 3.0 eV **(2)** 4.5 eV **(3)** 1.5 eV **(4)** 15.1 eV

17. One plano-convex and one plano-concave lens of same radius of curvature 'R' but of different materials are joined side by side as shown in the figure. If the refractive index of the material of 1 is μ_1 and that of 2 is μ_2, then the focal length of the combination is :



(1) $\dfrac{R}{2(\mu_1-\mu_2)}$ **(2)** $\dfrac{R}{2-(\mu_1-\mu_2)}$

(3) $\dfrac{2R}{(\mu_1-\mu_2)}$ **(4)** $\dfrac{R}{(\mu_1-\mu_2)}$

18. A message single of frequency 100 MHz and peak voltage 100 V is used to execute amplitude modulation on a carrier wave of frequency 300 GHz and peak voltage 400 V. The modulation index and difference between the two side band frequencies are:

(1) $4;1\times10^8\,Hz$ **(2)** $0.25;2\times10^8\,Hz$ **(3)** $4;2\times10^8\,Hz$ **(4)** $0.25;1\times10^8\,Hz$

19. The displacement of a damped harmonic oscillator is given by $x(t)=e^{-0.1t}\cos(10\pi t+\varphi)$. Here t is in seconds. The time taken for its amplitude of vibration to drop to half of its initial value is close to:

(1) 27s **(2)** 4s **(3)** 13s **(4)** 7s

20. A particle of mass m is moving along a trajectory given by

$x=x_0+a\cos\omega_1 t\;;\;\; y=y_0+b\sin\omega_2 t$

The torque, acting on the particle about the origin, at $t=0$ is:

(1) zero **(2)** $m(-x_0b+y_0a)\omega_1^2\hat{k}$

(3) $+my_0a\omega_1^2\hat{k}$ **(4)** $-m\left(x_0b\omega_2^2-y_0a\omega_1^2\right)\hat{k}$

21. The ratio of surface tensions of mercury and water is given to be 7.5 while the ratio of their densities is 13.6. Their contact angles, with glass, are close to 135° and 0°, respectively. It is observed that mercury gets depressed by an amount *h* in a capillary tube of radius r_1, while water rises b the same amount h in a capillary tube of radius r_2. The ratio, (r_1 / r_2), is then close to:

(1) $\frac{2}{5}$ **(2)** $\frac{2}{3}$ **(3)** $\frac{4}{5}$ **(4)** $\frac{3}{5}$

22. An npn transistor operates as a common emitter amplifier, with a power gain of 60 *dB*. The intput circuit resistance is 100Ω and the output load resistance is $10k\Omega$. The common emitter current gain β is:

(1) 10^4 **(2)** 60 **(3)** 10^2 **(4)** 6×10^2

23. A moving coil galvanometer allows a full scale current of 10^{-4}A. A series resistance of $2M\Omega$ is required to convert the above galvanometer into voltmeter of range 0-5 *V*. Therefore, the value of shunt resistance required to convert the above galvanometer into an ammeter of range 0-10 *mA* is:

(1) 10Ω **(2)** 100Ω **(3)** 500Ω **(4)** 200Ω

24. A $25\times10^{-3}m^3$ volume cylinder is filled with 1 mole of O_2 gas at room temperature (300 *K*). The molecular diameter of O_2, and its root mean square speed, are found to be 0.3 nm and 200 m/s, respectively. What is the average collision rate (per second) for an O_2 molecule?

(1) $\sim10^{11}$ **(2)** $\sim10^{12}$ **(3)** $\sim10^{10}$ **(4)** $\sim10^{13}$

25. The value of acceleration due to gravity at Earth's surface is $9.8ms^{-2}$. The altitude above its surface at which the acceleration due to gravity decreases to 4.9 ms^{-2}, is close to: (Radius of earth $=6.4\times10^6m$)

(1) 2.6×10^6m **(2)** 6.4×10^6m **(3)** 9.0×10^6m **(4)** 1.6×10^6m

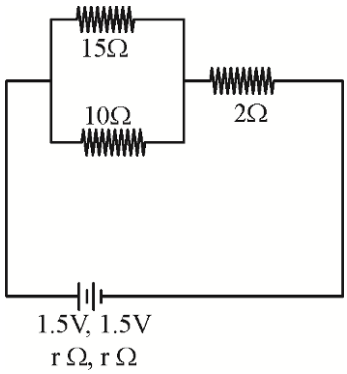
26. *n* moles of an ideal gas with constant volume heat capacity C_V undergo an isobaric expansion by certain volumes. The ratio of the work done in the process, to the heat supplied is:

(1) $\frac{4nR}{C_V-nR}$ **(2)** $\frac{nR}{C_V-nR}$ **(3)** $\frac{nR}{C_V+nR}$ **(4)** $\frac{4nR}{C_V+nR}$

27. Two coaxial discs, having moment of inertia I_1 and $\frac{I_1}{2}$, are rotating with respective angular velocities ω_1 and $\frac{\omega_1}{2}$, about their common axis. They are brought in contact with each other and thereafter they rotate with a common angular velocity. If E_f and E_i are the final and initial total energies, then (E_f-E_i) is:

(1) $-\frac{I_1\omega_1^2}{24}$ **(2)** $-\frac{I_1\omega_1^2}{12}$ **(3)** $\frac{3}{8}I_1\omega_1^2$ **(4)** $\frac{1}{6}I_1\omega_1^2$

28. In the given circuit, an ideal voltmeter connected across the 10Ω resistance reads $2V$. The internal resistance r, of each cell is:



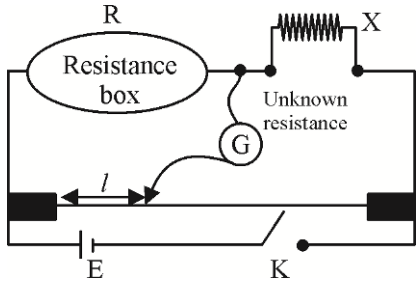
(1) 1Ω

(2) 0.5Ω

(3) 0Ω

(4) 1.5Ω

29. In a meter bridge experiment, the circuit diagram and the corresponding observation table are shown in figure.

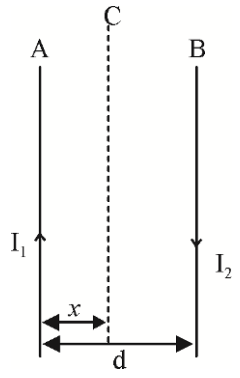


SI. NO.	$R(\Omega)$	$l(cm)$
1.	1000	60
2.	100	13
3.	10	1.5
4.	1	1.0

Which of the readings is inconsistent?

(1) 2 **(2)** 4 **(3)** 1 **(4)** 3

30. Two wires A and B are carrying currents I_1 & I_2 as shown in the figure. The separation between them is d. A third wire C carrying a current I is to be kept parallel to them at a distance x from A such that the net forces acting on its is zero. The possible values of x are :



(1) $x=\left(\frac{I_1}{I_1+I_2}\right)d$ and $x=\left(\frac{I_2}{I_1-I_2}\right)d$

(2) $x=\pm\left(\frac{I_1}{I_1-I_2}\right)d$

(3) $x=\left(\frac{I_1}{I_1-I_2}\right)d$ and $x=\frac{I_2}{(I_1+I_2)}d$

(4) $x=\left(\frac{I_2}{I_1+I_2}\right)d$ and $x=\frac{I_2}{(I_1-I_2)}d$

PART-B	CHEMISTRY

1. A gas undergoes physical adsorption on a surface and follows the given Freundlich adsorption isotherm equation $\frac{x}{m} = kp^{0.5}$

Adsorption of the gas increases with:

(1) Decrease in p and decrease in T **(2)** Increase in p and increase in T

(3) Increase in p and decrease in T **(4)** Decrease in p and increase in T

2. The regions of the atmosphere, where clouds form and where we live, respectively, are:

(1) Stratosphere and Stratosphere **(2)** Troposphere and Troposphere

(3) Stratosphere and Troposphere **(4)** Troposphere and Stratosphere

3. Match the refining methods (Column I) with metals (Column II).

	Column I (Refining methods)		**Column II** (Metals)
I.	Liquation	**(a)**	Zr
II.	Zone Refining	**(b)**	Ni
III.	Mond Process	**(c)**	Sn
IV.	Van Arkel Method	**(d)**	Ga

(1) (I)-(c); (II)-(a); (III)-(b); (IV)-(d) **(2)** (I)-(c); (II)-(d); (III)-(b); (IV)-(a)

(3) (I)-(b); (II)-(c); (III)-(d); (IV)-(a) **(4)** (I)-(b); (II)-(d); (III)-(a); (IV)-(c)

4. Amylopectin is composed of:

(1) β – D- glucose, $C_1 - C_4$ and $C_1 - C_6$ linkages

(2) α – D -glucose, $C_1 - C_4$ and $C_2 - C_6$ linkages

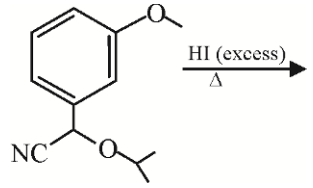
(3) β – D – glucose, $C_1 - C_4$ and $C_2 - C_6$ linkages

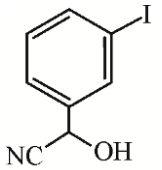
(4) α – D – glucose, $C_1 - C_4$ and $C_1 - C_6$ linkages

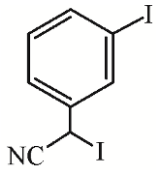
5. The synonym for water gas when used in the production of methanol is:

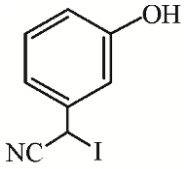
(1) fuel gas **(2)** syn gas **(3)** laughing gas **(4)** natural gas

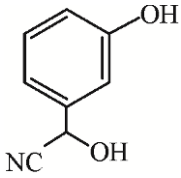
6. The major product of the following reaction is :



(1) 

(2) 

(3) 

(4) 

7. Ethylamine $\left(C_2H_5NH_2\right)$ can be obtained from N-ethylphtahlimide on treatment with:

(1) NH_2NH_2 **(2)** $NaBH_4$ **(3)** H_2O **(4)** CaH_2

8. Consider the following statements

(a) The pH of a mixture containing 400 mL of $0.1M H_2SO_4$ and 400 mL of 0.1 M NaOH will be approximately 1.3.

(b) Ionic product of water is temperature dependent.

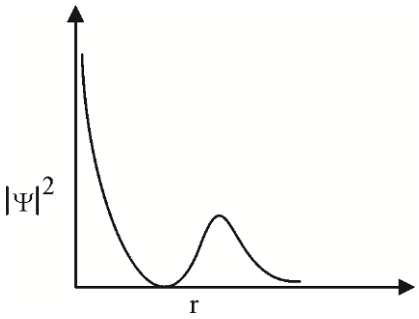
(c) A monobasic acid with $K_a = 10^{-5}$ has a $pH = 5$. The degree of dissociation of this acid is 50%

(d) The Le Chatelier's principle is not applicable to common-ion effect.

The correct statements are:

(1) (a) and (b) **(2)** (a), (b) and (c) **(3)** (b) and (c) **(4)** (a), (b) and (d)

9. The graph between $|\Psi|^2$ and r(radial distance) is shown below.



This represents:

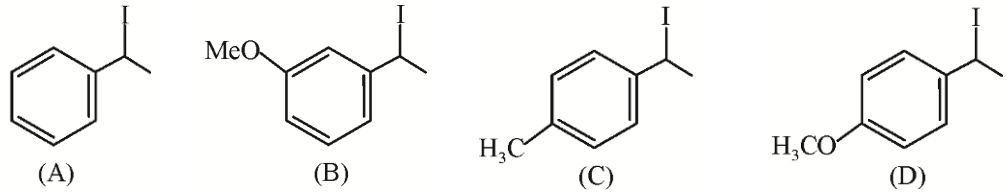
(1) 3s orbital

(2) 2p orbital

(3) 2s orbital

(4) 1s orbital

10. Increasing rate of S_N1 reaction in the following compounds is:



(A) (B) (C) (D)

(1) (A) < (B) < (D) < (C) **(2)** (B) < (A) < (C) < (D)

(3) (B) < (A) < (D) < (C) **(4)** (A) < (B) < (C) < (D)

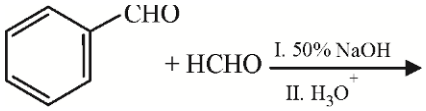
11. The species that can have a trans-isomer is:

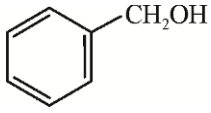
(en = ethane-1,2-diamine, ox = oxalate)

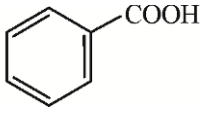
(1) $\left[Pt(en)Cl_2\right]$ **(2)** $\left[Pt(en)_2Cl_2\right]^{2+}$

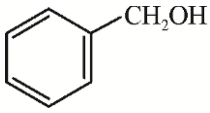
(3) $\left[Zn(en)Cl_2\right]$ **(4)** $\left[Cr(en)_2(ox)\right]^{+}$

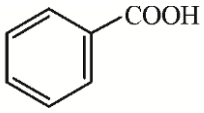
12. Major products of the following reactions are:



(1) CH_3OH and HCO_2H **(2)** HCOOH and 

(3) CH_3OH and 

(4) 

and 

13. The oxoacid of Sulphur that does not contain bond between Sulphur atoms is:

(1) $H_2S_2O_4$ **(2)** $H_2S_2O_7$ **(3)** $H_2S_2O_3$ **(4)** $H_2S_4O_6$

14. Which of the following is a condensation polymer?

(1) Buna-S **(2)** Teflon **(3)** Neoprene **(4)** Nylon 6,6

15. The principle of column chromatography is:

(1) Differential absorption of the substances on the solid phase.

(2) Gravitational force

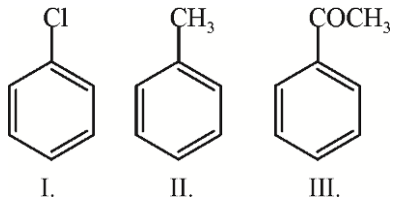
(3) Capillary action

(4) Differential adsorption of the substance on the solid phase.

16. At 300 K and 1 atmospheric pressure, 10 mL of a hydrocarbon required 55 mL of O_2 for complete combustion, and 40 mL of CO_2 is formed. The formula of the hydrocarbon is:

(1) C_4H_6 **(2)** C_4H_7Cl **(3)** C_4H_{10} **(4)** C_4H_8

17. The increasing order of the reactivity of the following compounds towards electrophilic aromatic substitution reactions is:



I. II. III.

(1) $I < III < II$ **(2)** $II < I < III$ **(3)** $III < I < II$ **(4)** $III < II < I$

18. At room temperature, a dilute solution of urea is prepared by dissolving 0.60 g of urea in 360 g of water. If the vapour pressure of pure water at this temperature is 35 mm Hg, lowering of vapour pressure will be: (molar mass of urea $= 60\,g\,mol^{-1}$)

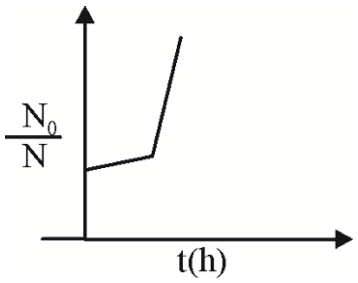
(1) 0.027 mm Hg **(2)** 0.031 mm Hg **(3)** 0.017 mm Hg **(4)** 0.028 mm Hg

19. The alloy used in the construction of aircrafts is:

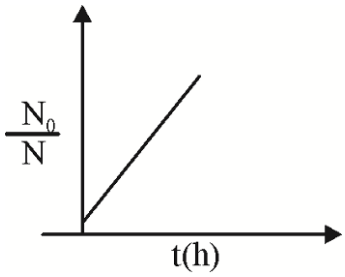
(1) Mg-Al **(2)** Mg-Zn **(3)** Mg-Sn **(4)** Mg-Mn

20. A bacterial infection in an internal wound grows as $N'(t) = N_0 \exp(t)$, where the time t is in hours. A dose of antibiotic, taken orally, needs 1 hour to reach the wound. Once it reaches there, the bacterial population goes down as $\frac{dN}{dt} = -5N^2$. What will be the plot of $\frac{N_0}{N}$ vs . t after 1 hour?

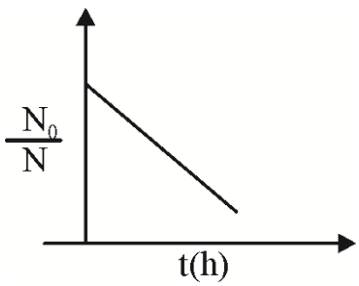
(1)



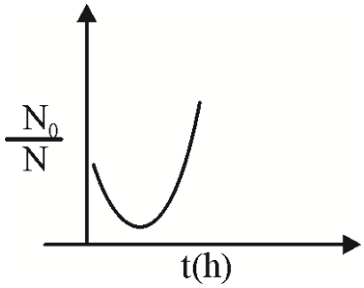
(2)



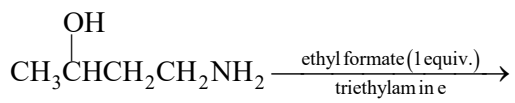
(3)



(4)

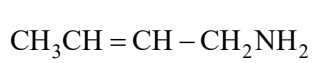


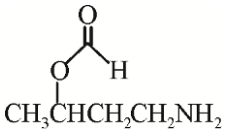
21. The major product of the following reaction is :



(1) 

(2) 

(3) 

(4) 

22. A process will be spontaneous at all temperatures if:

(1) $\Delta H < 0 \text{ and } \Delta S > 0$ **(2)** $\Delta H > 0 \text{ and } \Delta S < 0$

(3) $\Delta H < 0 \text{ and } \Delta S < 0$ **(4)** $\Delta H > 0 \text{ and } \Delta S > 0$

23. Consider the statements S1 and S2:

S1: Conductivity always increases with decrease in the concentration of electrolyte.

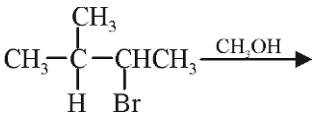
S2: Molar conductivity always increases with decrease in the concentration of electrolyte.

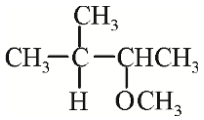
The correct option among the following is:

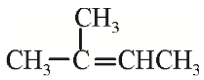
(1) Both S1 and S2 are wrong **(2)** S1 is correct and S2 is wrong

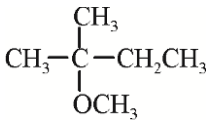
(3) S1 is wrong and S2 is correct **(4)** Both S1 and S2 are correct

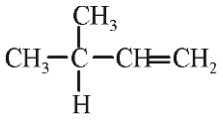
24. The major product of the following reaction is:



(1) 

(2) 

(3) 

(4) 

25. The isoelectronic set of ions is:

(1) $N^{3-}, O^{2-}, F^{-} \text{ and } Na^{+}$ **(2)** $Li^{+}, Na^{+}, O^{2-} \text{ and } F^{-}$

(3) $N^{3-}, Li^{+}, Mg^{2+} \text{and} O^{2-}$ **(4)** $F^{-}, Li^{+}, Na^{+} \text{and} Mg^{2+}$

26. Three complexes, $\left[CoCl(NH_3)_5\right]^{2+}(I), \left[Co(NH_3)_5 H_2O\right]^{3+}(II)$ and $\left[Co(NH_3)_6\right]^{3+}(III)$ absorb light in the visible region. The correct order of the wavelength of light absorbed by them is:

(1) (II) > (I) > (III) **(2)** (I) > (II) > (III) **(3)** (III) > (I) > (II) **(4)** (III) > (II) > (I)

27. Consider the following table:

Gas	$a / (k\,Pa\,dm^6 mol^{-1})$	$b / (dm^3 mol^{-1})$
A	642.32	0.05196
B	155.21	0.04136
C	431.91	0.05196

D	155.21	0.4382

a and b are van de Waals constants. The correct statements about the gases is:

(1) Gas C will occupy lesser volume than gas A; gas B will be more compressible than gas D

(2) Gas C will occupy lesser volume than gas A; gas B will be lesser compressible than gas D

(3) Gas C will occupy more volume than gas A; gas B will be more compressible than gas D

(4) Gas C will occupy more volume than gas A; gas B will be lesser compressible than gas D

28. During the change of O_2 to O_2^-, the incoming electron goes to the orbital;

(1) $\pi 2p_y$ **(2)** $\sigma^* 2p_z$ **(3)** $\pi^* 2p_x$ **(4)** $\pi 2p_x$

29. Consider the hydrated ions of Ti^{2+}, V^{2+}, Ti^{3+} and Sc^{3+}. The correct order of their spin-only magnetic moments is:

(1) $V^{2+} < Ti^{2+} < Ti^{3+} < Sc^{3+}$ **(2)** $Sc^{3+} < Ti^{3+} < V^{2+} < Ti^{2+}$

(3) $Sc^{3+} < Ti^{3+} < Ti^{2+} < V^{2+}$ **(4)** $Ti^{3+} < Ti^{2+} < Sc^{3+} < V^{2+}$

30. The correct order of catenation is:

(1) $C > Sn > Si \approx Ge$ **(2)** $Ge > Sn > Si > C$

(3) $Si > Sn > C > Ge$ **(4)** $C > Si > Ge \approx Sn$

PART-C	MATHEMATICS

1. If $f(x)=\begin{cases}\dfrac{\sin(p+1)x+\sin x}{x}, & x<0\\ q, & x=0\\ \dfrac{\sqrt{x+x^2}-\sqrt{x}}{x^{3/2}}, & x>0\end{cases}$

is continuous at $x=0$, then the ordered pair (p, q) is equal to :

(1) $\left(-\frac{1}{2},\frac{3}{2}\right)$ **(2)** $\left(\frac{5}{2},\frac{1}{2}\right)$ **(3)** $\left(-\frac{3}{2},\frac{1}{2}\right)$ **(4)** $\left(-\frac{3}{2},-\frac{1}{2}\right)$

2. If $\Delta_1=\begin{vmatrix} x & \sin\theta & \cos\theta\\ -\sin\theta & -x & 1\\ \cos\theta & 1 & x\end{vmatrix}$ and $\Delta_2=\begin{vmatrix} x & \sin 2\theta & \cos 2\theta\\ -\sin 2\theta & -x & 1\\ \cos 2\theta & 1 & x\end{vmatrix}, x\neq 0$; then for all $\theta\in\left(0,\frac{\pi}{2}\right)$:

(1) $\Delta_1-\Delta_2=-2x^3$ **(2)** $\Delta_1+\Delta_2=-2x^3$

(3) $\Delta_1-\Delta_2=x(\cos 2\theta-\cos 4\theta)$ **(4)** $\Delta_1+\Delta_2=-2\left(x^3+x-1\right)$

3. If α and β are the roots of the quadratic equation, $x^2+x\sin\theta-2\sin\theta=0, \theta\in\left(0,\frac{\pi}{2}\right)$, then $\dfrac{\alpha^{12}+\beta^{12}}{\left(\alpha^{-12}+\beta^{-12}\right)(\alpha-\beta)^{24}}$ is equal to

(1) $\dfrac{2^{12}}{(\sin\theta-8)^6}$ **(2)** $\dfrac{2^{12}}{(\sin\theta+8)^{12}}$ **(3)** $\dfrac{2^{12}}{(\sin\theta-4)^{12}}$ **(4)** $\dfrac{2^6}{(\sin\theta+8)^{12}}$

4. If $a>0$ and $z=\dfrac{(1+i)^2}{a-i}$, has magnitude $\sqrt{\frac{2}{5}}$, then $\bar{z}$ is equal to:

(1) $-\frac{3}{5}-\frac{1}{5}i$ **(2)** $-\frac{1}{5}-\frac{3}{5}i$ **(3)** $-\frac{1}{5}+\frac{3}{5}i$ **(4)** $\frac{1}{5}-\frac{3}{5}i$

5. If a directrix of a hyperbola centred at the origin and passing through the point $\left(4,-2\sqrt{3}\right)$ is $5x=4\sqrt{5}$ and its eccentricity is e, then:

(1) $4e^4-24e^2+27=0$ **(2)** $4e^4-12e^2-27=0$

(3) $4e^4+8e^2-35=0$ **(4)** $4e^4-24e^2+35=0$

6. The line $x=y$ touches a circle at the point (1, 1). If the circle also passes through the point $(1,-3)$, then its radius is :

(1) $3\sqrt{2}$ **(2)** 3 **(3)** $2\sqrt{2}$ **(4)** 2

7. If the circles $x^2+y^2+5Kx+2y+K=0$ and $2\left(x^2+y^2\right)+2Kx+3y-1=0, (K\in R)$, intersect at the points P and Q, then the line $4x+5y-K=0$ passes through P and Q for:

(1) exactly one value of K **(2)** infinitely many values of K

(3) no value of K **(4)** exactly two values of K

8. If the system of linear equations $x+y+z=5$, $x+2y+2z=6$, $x+3y+\lambda z=\mu, (\lambda,\mu\in R)$ has infinitely many solutions, then the value of $\lambda+\mu$ is:

(1) 7 **(2)** 9 **(3)** 10 **(4)** 12

9. $\lim\limits_{n\to\infty}\left(\frac{(n+1)^{1/3}}{n^{4/3}}+\frac{(n+2)^{1/3}}{n^{4/3}}+.....+\frac{(2n)^{1/3}}{n^{4/3}}\right)$ is equal to:

(1) $\frac{4}{3}(2)^{3/4}$ **(2)** $\frac{3}{4}(2)^{4/3}-\frac{4}{3}$ **(3)** $\frac{4}{3}(2)^{4/3}$ **(4)** $\frac{3}{4}(2)^{4/3}-\frac{3}{4}$

10. If $y=y(x)$ is the solution of the differential equation $\frac{dy}{dx}=(\tan x-y)\sec^2 x,\ x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$, such that $y(0)=0$, then $y\left(-\frac{\pi}{4}\right)$ is equal to :

(1) $e-2$ **(2)** $2+\frac{1}{e}$ **(3)** $\frac{1}{e}-2$ **(4)** $\frac{1}{2}-e$

11. If $\lim\limits_{x\to1}\frac{x^4-1}{x-1}=\lim\limits_{x\to k}\frac{x^3-k^3}{x^2-k^2}$, then k is :

(1) $\frac{3}{2}$ **(2)** $\frac{4}{3}$ **(3)** $\frac{8}{3}$ **(4)** $\frac{3}{8}$

12. If the line $x-2y=12$ is tangent to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ at the point $\left(3,-\frac{9}{2}\right)$, then the length of the latus rectum of the ellipse is:

(1) 9 **(2)** $8\sqrt{3}$ **(3)** 5 **(4)** $12\sqrt{2}$

13. Let $f(x)=e^x-x$ and $g(x)=x^2-x,\forall x\in R$. Then the set of all $x\in R$, where the function $h(x)=(fog)(x)$ is increasing, is:

(1) $[0,\infty)$ **(2)** $\left[-1,\frac{-1}{2}\right]\cup\left[\frac{1}{2},\infty\right)$

(3) $\left[0,\frac{1}{2}\right]\cup[1,\infty)$ **(4)** $\left[-\frac{1}{2},0\right]\cup[1,\infty)$

14. The number of 6 digit numbers that can be formed using the digits 0, 1, 2, 5, 7 and 9 which are divisible by 11 and no digit is repeated, is:

(1) 60 **(2)** 72 **(3)** 48 **(4)** 36

15. If the length of the perpendicular from the point $(\beta, 0, \beta)$ $(\beta\neq0)$ to the line, $\frac{x}{1}=\frac{y-1}{0}=\frac{z+1}{-1}$ is $\sqrt{\frac{3}{2}}$, then β is equal to:

(1) -2 **(2)** 2 **(3)** -1 **(4)** 1

16. Which one of the following Boolean expression is a tautology?

(1) $(p\vee q)\wedge(p\vee\sim q)$ **(2)** $(p\wedge q)\vee(p\wedge\sim q)$

(3) $(p\vee q)\wedge(\sim p\vee\sim q)$ **(4)** $(p\vee q)\vee(p\vee\sim q)$

17. The value of $\int_0^{2\pi}[\sin 2x(1+\cos 3x)]dx$, where [$t$] denotes the greatest integer function, is:

(1) $-\pi$ **(2)** 2π **(3)** π **(4)** -2π

18. The sum $\frac{3\times1^3}{1^2}+\frac{5\times\left(1^3+2^3\right)}{1^2+2^2}+\frac{7\times\left(1^3+2^3+3^3\right)}{1^2+2^2+3^2}+.....$ upto 10^{th} term, is :

(1) 680 **(2)** 620 **(3)** 660 **(4)** 600

19. ABC is a triangular park with $AB=AC=100\,metres.$ A vertical tower is situated at the mid-point of BC. If the angles of elevation of the top of the tower at A and B are $\cot^{-1}\left(3\sqrt{2}\right)$ and $\text{cosec}^{-1}\left(2\sqrt{2}\right)$ respectively, then the height of the tower (in meters) is:

(1) $\frac{100}{3\sqrt{3}}$ **(2)** 25 **(3)** 20 **(4)** $10\sqrt{5}$

20. If the coefficients of x^2 and x^3 are both zero, in the expansion of the expression $\left(1+ax+bx^2\right)(1-3x)^{15}$ in powers of x, then the ordered pair (a,b) is equal to:

(1) $(-21,714)$ **(2)** $(-54,315)$ **(3)** $(28,861)$ **(4)** $(28,315)$

21. The region represented by $|x-y|\le2$ and $|x+y|\le2$ is bounded by a:

(1) rhombus of side length 2 units **(2)** square of side length $2\sqrt{2}$ units

(3) square of area 16 sq. units **(4)** rhombus of area $8\sqrt{2}$ aq. units.

22. Let $f:R\to R$ be differentiable at $c\in R$ and $f(c)=0$. If $g(x)=|f(x)|,$ then at $x=c,$ g is :

(1) differentiable if $f'(c)\neq0$ **(2)** not differentiable

(3) differentiable if $f'(c)=0$ **(4)** not differentiable if $f'(c)=0$

23. If for some $x\in R,$ the frequency distribution of the marks obtained by 20 students in a test is:

Marks	2	3	5	7
Frequency	$(x+1)^2$	$2x-5$	x^2-3x	x

Then the mean of the marks is:

(1) 3.2 **(2)** 2.8 **(3)** 3.0 **(4)** 2.5

24. If $\int\frac{dx}{\left(x^2-2x+10\right)^2}=A\left(\tan^{-1}\left(\frac{x-1}{3}\right)+\frac{f(x)}{x^2-2x+10}\right)+C$

Where C is a constant of integration, then:

(1) $A=\frac{1}{54}$ and $f(x)=9(x-1)^2$ **(2)** $A=\frac{1}{27}$ and $f(x)=9(x-1)$

(3) $A=\frac{1}{81}$ and $f(x)=3(x-1)$ **(4)** $A=\frac{1}{54}$ and $f(x)=3(x-1)$

25. Let $A(3,0,-1),B(2,10,6)$ and $C(1,2,1)$ be the vertices of a triangle and M be the midpoint of AC. If G divides BM in the ratio, 2:1, then $cos(\angle GOA)$ (O being the origin) is equal to:

(1) $\frac{1}{2\sqrt{15}}$ **(2)** $\frac{1}{\sqrt{30}}$ **(3)** $\frac{1}{\sqrt{15}}$ **(4)** $\frac{1}{6\sqrt{10}}$

26. Let $f(x)=x^2, x\in R$. For any $A\subseteq R$, define $g(A)=\{x\in R: f(x)\in A\}$. If $S=[0,4]$, then which one of the following statements is not true?

(1) $f(g(S))\neq f(S)$ **(2)** $g(f(S))\neq S$

(3) $f(g(S))=S$ **(4)** $g(f(S))=g(S)$

27. All the pairs (x, y) that satisfy the inequality $2^{\sqrt{\sin^2 x-2\sin x+5}}.\frac{1}{4^{\sin^2 y}}\leq 1$ also satisfy the equation:

(1) $\sin x=2\sin y$ **(2)** $\sin x=|\sin y|$

(3) $2|\sin x|=3\sin y$ **(4)** $2\sin x=\sin y$

28. If $Q(0,-1,-3)$ is the image of the point P in the plane $3x-y+4z=2$ and R is the point $(3,-1,-2)$, then the area (in sq. units) of ΔPQR is:

(1) $\frac{\sqrt{91}}{4}$ **(2)** $2\sqrt{13}$ **(3)** $\frac{\sqrt{65}}{2}$ **(4)** $\frac{\sqrt{91}}{2}$

29. If $a_1, a_2, a_3, ..., a_n$ are in A.P. and $a_1+a_4+a_7+.....+a_{16}=114$, then $a_1+a_6+a_{11}+a_{16}$ is equal to:

(1) 76 **(2)** 64 **(3)** 38 **(4)** 98

30. Assume that each born child is equally likely to be a boy or a girl. If two families have two children each, then the conditional probability that all children are girls given that at least two are girls is:

(1) $\frac{1}{17}$ **(2)** $\frac{1}{10}$ **(3)** $\frac{1}{12}$ **(4)** $\frac{1}{11}$