FIITJEE (JEE-Advanced)

BATCHES – NWCM822O1S, NWCM2022S1W, NWCM2022A1R, NWCM2022A2R + DEHRADUN-2022R, NWCM2022A3R, NWCM2022B1R, NWCM2022B1W, NWCM2022G1, NWCM2022A1W, NWCM2022A2W, NWCM2022A3W, NWCM2022A4W, NWCM2022A5W, NWCM2022A6W, NWCM2022A7W, NWCM2022A8W, PANINI2022-G1, PANINI2022-XII 1, PANINI2022-XII 2, PANINI2022-XII 3, NWCM2022E1R+NWCM2022E1W, NWCM2022EW, RCM2022B1R, RCM2022B1W, PANINI2022B01

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 1 | **QP Code:** | **RIT – 1**

Time Allotted: 3 Hours **Maximum Marks: 198**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-06) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-A (07-12) –** Contains seven (06) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –1 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–1** marks, as a wrong option is also darkened.

(ii) **Part-B (01-06)** contains Six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :_____

Batch :_____ **Date of Examination :**_____

Enrolment Number :_____

SECTION-1 : PHYSICS

PART – A

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A point moves in xy plane according to equation x = at, y = at(1-bt) where a and b are positive constants and t is time. The instant at which velocity vector is at $\pi/4$ with acceleration vector is given by

(A) $\frac{1}{a}$ (B) $\frac{1}{b}$ (C) $\frac{1}{a}+\frac{1}{b}$ (D) $\frac{a+b}{a^2+b^2}$

1. **B**

2. If $|\vec{A}|=|\vec{B}|$ and $\vec{A}\neq\pm\vec{B}$ then angle between the vectors $(\vec{A}+\vec{B})$ and $(\vec{A}-\vec{B})$ is

(A) 0 (B) $\frac{\pi}{6}$ (C) $\frac{\pi}{3}$ (D) $\frac{\pi}{2}$

2. **D**

3. A vector of magnitude a is turned through angle θ. The magnitude of change in the vector is given by

(A) $|2a\sin\theta|$ (B) $|2a\sin(\theta/2)|$

(C) $\left|\frac{a}{2}\sin\theta\right|$ (D) $\left|\frac{a}{2}\sin\left(\frac{\theta}{2}\right)\right|$

3. **B**

4. A train passes an observer standing on a platform. The first carriage of the train passes the observer in time t_1 = 1sec and the second carriage in t_2 = 1.5 sec. Find its acceleration assuming it to be constant. The length of each carriage is ℓ = 12 m.

(A) $3.3\ m/sec^2$ (B) $-3.2\ m/sec^2$

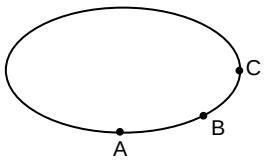
(C) 24 m/sec^2 (D) -24 m/sec^2

4. **B**

5. A particle is moving on an elliptical path as shown, speed of the particle is constant. Its acceleration is minimum at

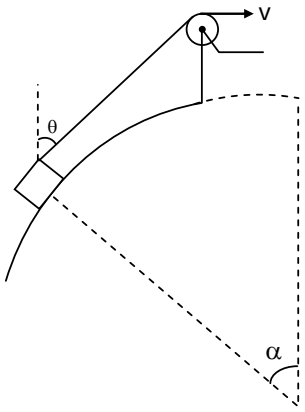
(A) A (B) B

(C) C (D) same everywhere



5. **A**

6. A block is dragged on smooth curved plane with the help of a rope which moves with a speed v as shown in figure. The speed of block at this instant will be



(A) $\frac{V}{\sin(\theta+\alpha)}$

(B) $\frac{V}{\cos(\theta+\alpha)}$

(C) $\frac{V}{\sin(\theta-\alpha)}$

(D) none of the above

6. **A**

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

7. A particle of mass m moves on the x axis as follows. It starts from rest at t = 0 from the point x = 0 and comes to rest at t = 1 at the point x = 1. No other information is available about its motion at intermediate times (0<t<1). If α denotes the instantaneous acceleration of the particle, then

(A) α cannot remain positive for all t in the interval $0 \le t \le 1$

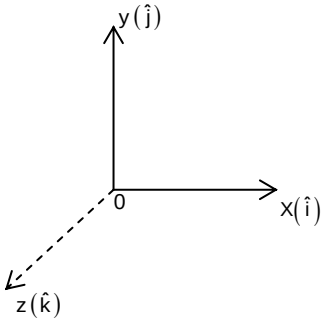
(B) $|\alpha|$ can not exceed 2 at any point in its path

(C) $|\alpha|$ must be ≥ 4 at some point or points in its path

(D) α must change sign during the motion, but no other assertion can be made with the information given.

7. **AC**

8. A particle is projected from origin with velocity $\vec{u} = \left(\hat{i} + \hat{j} + \sqrt{2}\hat{k}\right)$ m/s. Horizontal surface lies in X – Y plane, then (take g = 10 m/sec^2)



(A) Time of flight = $\frac{\sqrt{2}}{5}$ sec

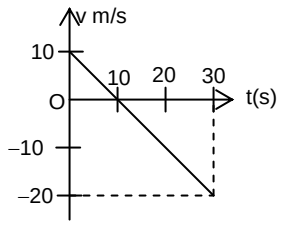
(B) horizontal range = $\frac{2}{5}$ m

(C) Maximum height $\frac{1}{10}$ m

(D) Maximum height = $\frac{1}{5}$ m

8. **ABC**

9. The velocity-time graph for a particle moving on a straight line is shown in figure.



(A) the particle has constt. acceleration

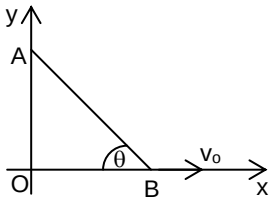
(B) the particle has never turned around

(C) the particle has zero displacement

(D) the average speed in the interval 0 to 10 s is the same as the average speed in the interval 10 s to 20 s.

9. **AD**

10. The end B of the rod AB which makes angle θ with the floor is being pulled with a constant velocity v_o as shown. The length of the rod is ℓ. At the instant when $\theta = 37^o$



(A) velocity of end A is $\frac{4}{3}v_o$ downwards

(B) angular velocity of rod is $\frac{5}{3}\frac{v_o}{\ell}$

(C) angular velocity of rod is constant

(D) velocity of end A is constant

10. **AB**

11. A particle moves along positive branch of the curve, $y = \frac{x}{2}$, where $x = \frac{t^3}{3}$, x and y are measured in metres and t in seconds, then

(A) The velocity of particle at $t = 1s$ is $\hat{i} + \frac{1}{2}\hat{j}$

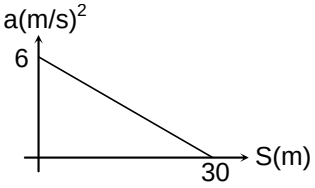
(B) The velocity of particle at t =1s is $\frac{1}{2}\hat{i} + \hat{j}$

(C) The acceleration of particle at t =1s is $2\hat{i} + \hat{j}$

(D) The acceleration of particle at t = 2 s is $\hat{i} + 2\hat{j}$

11. **AC**

12. A train starts from rest at *S* = 0 and is subjected to acceleration as shown



(A) Change in velocity at the end of 10 m displacement is 50 m/s.

(B) Velocity of the train for *S* = 10 m is 10 m/s.

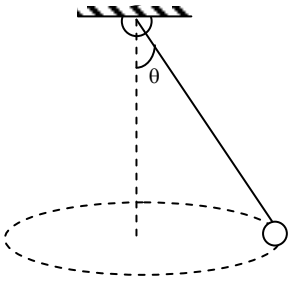
(C) The maximum velocity attained by train is not greater than 14 m/s.

(D) The maximum velocity of the train is between 15 m/s and 16 m/s.

12. **BC**

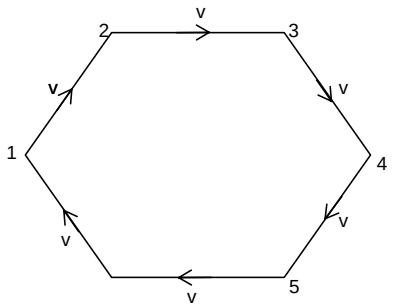
PART – B
(Numerical based)

13 In the conical pendulum, the centripetal force will be (θ = 45^0, m = 0.1 kg, g = 10 m/s^2)



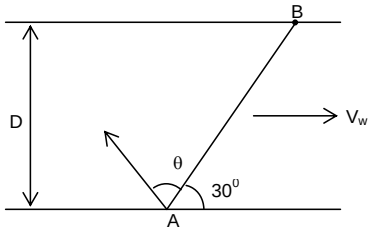
13. **1.00**

14. Six particles move in a cyclic manner along the sides of a regular hexagon of side ℓ as shown in the figure, when the speed of each particle is V the particles lie always at the vertices of a hexagon. When will the side of the hexagon be halved ? ℓ = 1m, v = 1 m/sec



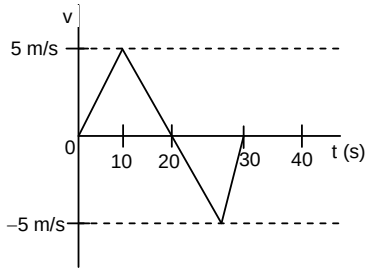
14. **1.00**

15. Two ports A and B are separated by a river of width D. Water in the river flows with speed V_W. A boat crosses the river form port A to port B. The speed of the boat relative to water is V_B. Given $V_W = \sqrt{3}\ V_B$. if at angle $\theta = \frac{\pi}{n}$ (in radian) with AB in which the boat should start relative to water so that it moves along A, then find the value of n



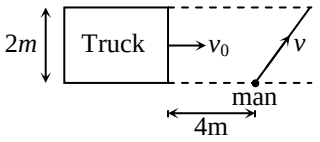
15. **3.00**

16. From the velocity-time plot shown in figure. The average velocity during this period is N



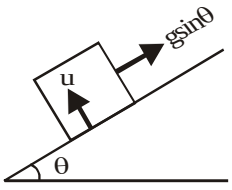
16. **0.83 (Range: 0.83 to 0.84)**

17. A 2m wide truck is moving with a uniform speed v_0 = 8 m/s along a straight horizontal road. A pedestrian starts to cross the road with a uniform speed v when the truck is 4 m away from him. The minimum value of velocity so that he can cross the road safely is v then the value of $\frac{2}{\sqrt{5}}$v is



17. **3.20**

18. A cabin is moved up the inclined plane with constant acceleration g sinθ. A particle is projected with some velocity in a direction perpendicular to the inclined plane. If maximum height attained by particle perpendicular to inclined plane is same as range of particle with respect to the cabin parallel to plane then calculate values of $\frac{\cot\theta}{5}$.



18. **1.60**

SECTION-2 : CHEMISTRY

PART – A

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Reaction between P_4O_{10} and CaO produces only calcium phosphate. In what molar ratio will P_4O_{10} and CaO react to produce one mole calcium phosphate?
(A) 1 : 4 (B) 1 : 3
(C) 1 : 6 (D) 1 : 8

1. C

2. A 20 L container holds an ideal gas at 0.4 atm and a 10 L container holds an ideal gas at 0.2 atm pressure at constant temperature. What will be the pressure if the gases from the two containers are transferred into an one litre container?
(A) 12 atm (B) 10 atm
(C) 6 atm (D) 8 atm

2. B

3. The energy of the first orbit of H-atom is -13.6 eV. The energy of the first orbit of a H-like species is -122.4 eV. How many protons are present in the nucleus of the H-like species?
(A) 1 (B) 2
(C) 3 (D) 4

3. C

4. $CO_2 + C \longrightarrow 2CO$

Which is incorrect statement for the reaction?
(A) It is a comproportionation reaction
(B) Equivalent mass of CO_2 is 22 g equ^{-1}
(C) The n-factor of all the reacting species(CO_2, C and CO) are same
(D) Carbon does not follow the law of chemical combination

4. D

5. The van der Waal's constants (a and b) for four gases given below:

Gases	$(a \times 10^{-3})$ in atm L^2mol^{-2}	$(b \times 10^{-2})$ in L mol^{-1}
P	8	4
Q	6	5
R	10	6
S	5	2

Which gas can be easily liquefied?
(A) P (B) Q
(C) R (D) S

5. D

6. The de-Broglie wavelength of a fundamental particle of mass 'm' at temperature 'T' is expressed as

$$\lambda = \frac{h}{\sqrt{3mkT}}$$

Where h = Planck's constant and k = Boltzmann constant
Choose the incorrect statement
(A) The particle should not interact with other particles during motion

(B) The particle moves with root mean square velocity

(C) The kinetic energy of one particle is $\frac{3}{2}RT$

(D) If the de-Broglie wavelength of a proton is $x\,\overset{o}{A}$, then the wavelength for the alpha particle moving at same temperature will be $\frac{x}{2}\overset{o}{A}$

6. C

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

7. 5 moles of a mixture of $FeSO_4$ and $Fe_2(SO_4)_3$ requires 400 mL of 0.5 M acidified $KMnO_4$ for complete oxidation.
Choose the correct statement(s)
(A) Mole fraction of $FeSO_4$ in the mixture is 0.2.
(B) n-factor of $FeSO_4$ in the reaction is one.
(C) Milli equivalent of acidified MnO_4^- ion required in the reaction is 200.
(D) One mole of $KMnO_4$ can oxidize five moles of $Fe_2(SO_4)_3$.

7. AB

8. Which of the following is/are the factors of root mean square velocity?
(A) Molar mass of the gas (B) Temperature
(C) Density of gas (D) Pressure of gas

8. AB

9. The set of quantum numbers for an electron is n = 4, ℓ = 1, m = 0, s = +½
Choose correct statement(s) for the electron
(A) Orbital angular momentum of this electron is higher than that of the valence electron of calcium.
(B) If the wave function of the orbital in which the electron present is Ψ, then Ψ^2 has the lowest value at two positions on the radial axis of the orbital
(C) The orbital has two angular nodes, one along X-axis and the other Y-axis
(D) If the electron is one of the valence electrons of an atom, then the atom should contain eight d-electrons.

9. AB

10. A mixture of Na_2CO_3 and $NaHCO_3$ required x mL of HCl solution in presence of phenolphthalein indicator. Further y mL of same HCl solution was required with methyl orange indicator.
Choose the correct statements
(A) y > x
(B) Total volume of HCl required for complete reaction of Na_2CO_3 is 2x mL
(C) Volume of HCl required for complete reaction of $NaHCO_3$ is (x + y) mL
(D) No gas is formed in the complete reaction

10. AB

11.

Orbits	Number of electrons
n = 1	2
n = 2	8
n = 3	18
n = 4	6

The electron configuration of an atom is given above. Choose correct statement(s)

(A) The atom contains eight electrons with $\ell = 0$. ℓ = azimuthal quantum number.

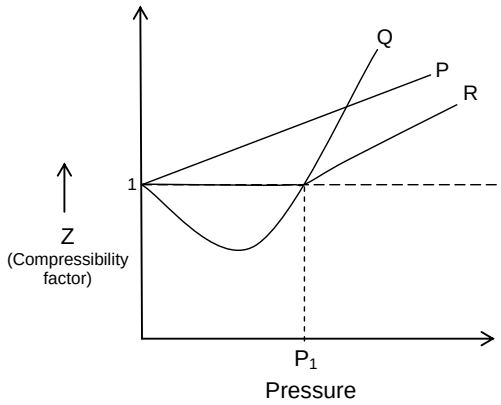
(B) The $(n + \ell)$ values for the highest energetic electron of the atom is 5.

(C) On excitation with the lowest amount of energy, the electron moves to 4d orbitals

(D) The outer electronic configuration of the atom displays Hund's rule.

11. ABD

12.



Choose correct statement(s) from the following

(A) For gas(Q), force of attraction dominates over force of repulsion between the gas particles upto pressure P_1.

(B) All three gases show ideal behaviour at P_1

(C) Compressibility order of the three gases is Q > R > P

(D) At all the pressure range gas (P) shows positive deviation from ideal behavior except at zero pressure.

12. ACD

PART – B
(Numerical based)

13. $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$

15 mL each of CO and O_2 are subjected to reaction in which the limiting reactant is consumed completely. What will be the total volume of reaction mixture after reaction in mL unit?

13. 22.5

14. The orbital angular momentum of an electron is $\frac{h}{\sqrt{2}\,\pi}$ Kg $m^2 s^{-1}$. What is the azimuthal quantum number of the orbital?

14. 1

15. What is the most probable velocity of an ideal gas(Molar mass = 32 g mol^{-1}) in ms^{-1} unit? [RT = 1000 J]

15. 250

16. The vapour density of an ideal gas is 10. What will be its density in 1 atm pressure in g/L unit?
[RT = 100 L atm mol^{-1}]

16. 0.2

17. 100 mL of helium takes 5 sec to effuse through an orifice. How much time in sec is required by 200 mL of CH_4 to effuse through the same orifice at constant temperature and pressure?

17. 20

18. If the wavelength of the first line of Balmer series of hydrogen spectrum is expressed as $\left(\frac{x}{y}\times 10^{-7}\right)$m, what is the sum (x + y)? [Rydberg constant = 1×10^7 m^{-1}]

18. 41

SECTION-3 : MATHEMATICS

PART – A

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. If $\tan\alpha = \frac{m}{m+1}, \tan\beta = \frac{1}{2m+1}$, then $\alpha+\beta$ is equal to

   (A) $\frac{\pi}{4}$ (B) $\frac{\pi}{3}$

   (C) $\tan^{-1}\frac{m}{2m+1}$ (D) $\tan^{-1}\frac{m+1}{2m+1}$

1. A

2. Let x and y be real numbers such that $\frac{\sin x}{\sin y} = 3$ and $\frac{\cos x}{\cos y} = \frac{1}{2}$. The value of $\frac{\sin 2x}{\sin 2y} + \frac{\cos 2x}{\cos 2y}$ is

   (A) $\frac{49}{58}$ (B) $\frac{41}{58}$

   (C) $\frac{51}{58}$ (D) none of these

2. A

3. Given $A = \sin^2\theta + \cos^4\theta$, then for all real θ,

   (A) $1 \le A \le 2$ (B) $\frac{3}{4} \le A \le 1$

   (C) $\frac{8}{10} \le A \le \frac{9}{10}$ (D) $\frac{3}{4} \le A \le \frac{13}{16}$

3. B

4. If $\left(\cos^2 x + \frac{1}{\cos^2 x}\right)\left(1+\tan^2 2y\right)\left(3+\sin 3z\right) = 4$, then y can take values equal to

   (A) $\frac{\pi}{4}$ (B) $\frac{\pi}{3}$

   (C) $\frac{\pi}{2}$ (D) none of these

4. C

5. Value of $\cos\frac{\pi}{2n+1} + \cos\frac{3\pi}{2n+1} + \cos\frac{5\pi}{2n+1} + \ldots\ldots$ upto n terms equals

   (A) $\frac{1}{2}$ (B) 1

   (C) $\frac{\sqrt{3}}{2}$ (D) none of these

5. A

6. If $\tan\beta = 2\sin\alpha.\sin\gamma.\cos ec(\alpha+\gamma)$, then $\cot\alpha, \cot\beta, \cot\gamma$ are in:

(A) A.P. (B) G.P.
(C) H.P. (D) None of these

6. A

(Multi Correct Choice Type)

This section contains 6 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

7. Let $f_n(\theta) = \tan\frac{\theta}{2}(1+\sec\theta)(1+\sec 2\theta)(1+\sec 4\theta).....(1+\sec 2^n\theta)$, then

(A) $f_2\left(\frac{\pi}{16}\right)=1$ (B) $f_3\left(\frac{\pi}{32}\right)=1$
(C) $f_4\left(\frac{\pi}{64}\right)=1$ (D) $f_5\left(\frac{\pi}{128}\right)=1$

7. ABCD

8. If $\sin\beta$ is the geometric mean between $\sin\alpha$ and $\cos\alpha$, then $\cos 2\beta$ is equal to

(A) $2\sin^2\left(\frac{\pi}{4}-\alpha\right)$ (B) $2\cos^2\left(\frac{\pi}{4}-\alpha\right)$
(C) $2\cos^2\left(\frac{\pi}{4}+\alpha\right)$ (D) $2\sin^2\left(\frac{\pi}{4}+\alpha\right)$

8. AC

9. Which of the following when simplified reduces to unity?

(A) $\frac{1-2\sin^2\alpha}{2\cot\left(\frac{\pi}{4}+\alpha\right)\cos^2\left(\frac{\pi}{4}-\alpha\right)}$ (B) $\frac{\sin(\pi-\alpha)}{\sin\alpha-\cos\alpha\tan\frac{\alpha}{2}}+\cos(\pi-\alpha)$
(C) $\frac{1}{4\sin^2\alpha\cos^2\alpha}+\frac{\left(1-\tan^2\alpha\right)^2}{4\tan^2\alpha}$ (D) $\frac{1+\sin 2\alpha}{(\sin\alpha+\cos\alpha)^2}$

9. ABD

10. If $a=\frac{1}{5\cos x+12\sin x}$, then for all real x,

(A) the least positive value of a is $\frac{1}{13}$ (B) the greatest negative value of a is $-\frac{1}{13}$
(C) $a\le\frac{1}{13}$ (D) $-\frac{1}{13}\le a\le\frac{1}{13}$

10. AB

11. The value of $\cos^2 10^o - \cos 10^o \cos 50^o + \cos^2 50^o$ is equal to

(A) $\frac{4}{3}$ (B) $\frac{1}{3}$

(C) $\frac{3}{4}$ (D) 3

11. C

12. If $\sin t + \cos t = \frac{1}{5}$ then $\tan\frac{t}{2}$ is equal to

(A) –1 (B) $-\frac{1}{3}$

(C) 2 (D) $-\frac{1}{6}$

12. BC

PART – B
(Numerical based)

13. $\left(1+\tan 1^o\right)\left(1+\tan 2^o\right)\left(1+\tan 43^o\right)\left(1+\tan 44^o\right)$ equal to

13. 4

14. In triangle ABC, if $\angle c = \frac{\pi}{2}$ and $\frac{x}{y} = \frac{\cos A}{\cos B}$ then $\frac{x\tan A + y\tan B}{x+y} =$

14. 1

15. If $2n\cos 20^o = \sin 40^o + n\cos 40^o$, then $\frac{1}{n^2}$ is equal to

15. 3

16. If $\sin 2\theta + \sin 2\phi = \frac{1}{2}$ and $\cos 2\theta + \cos 2\phi = \frac{3}{2}$ and $\cos^2(\theta - \phi)$ is equal to k then 2k =

16. 1.25

17. The absolute value of $\cos 12^o + \cos 84^o + \cos 156^o + \cos 132^o$ is

17. 0.50

18. If $\cos(\alpha - \beta) = 3\sin(\alpha + \beta)$, then $\left|\frac{1}{1-3\sin 2\alpha} + \frac{1}{1-3\sin 2\beta}\right|$ is equal to

18. 0.25

ANSWERS

SECTION-1 : PHYSICS

PART – A

PART – B

SECTION – 2 : CHEMISTRY

PART – A

PART – B

SECTION – 3 : MATHEMATICS

PART – A

PART – B