Question: JEE (Advanced) 2024

Paper 1

1/10

SECTION 1 (Maximum Marks: 12)

This section contains FOUR (04) questions.

Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct

answer.

For each question, choose the option corresponding to the correct answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;

Zero Marks

: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 1 In all other cases.

Q.1

Let

( )

f x be a continuously differentiable function on the interval (0,

)

such that

(1)

2

f

=

and

10

10

9

9

( )

( )

lim

1

t

x

t

f x

x f t

t

x

=

for each

0.

x

Then, for all

0,

x

( )

f x is equal to

(A)

10

31

9

11

11 x

x

(B)

10

9

13

11

11 x

x +

(C)

10

9

31

11

11 x

x

+

(D)

10

13

9

11

11 x

x +

Q.2

A student appears for a quiz consisting of only true-false type questions and answers all the questions.

The student knows the answers of some questions and guesses the answers for the remaining questions. Whenever the student knows the answer of a question, he gives the correct answer.

Assume that the probability of the student giving the correct answer for a question, given that he has guessed it, is $\frac{1}{2}$.

Also assume that the probability of the answer for a question being guessed, given that the student s answer is correct, is $\frac{1}{6}$.

Then the probability that the student knows the answer of a randomly chosen question is

(A) $\frac{1}{12}$

(B) $\frac{1}{7}$

(C) $\frac{5}{7}$

(D) $\frac{5}{12}$

Mathematics

Answer: Here is a detailed answer to the two questions:

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Q.3

Let 2

x

be such that

5

cot

.

11

x

=

Then

(

)

(

)

11

11

sin

sin 6

cos6

cos

sin 6

cos6

2

2

x

x

x

x

x

x

+

+

is equal to

(A) 11 1

2 3

(B) 11 1

2 3

+

(C) 11 1

3 2

+

(D) 11 1

3 2

Q.4

Consider the ellipse

2

2

1.

9

4

x

y

+

=

Let (,)

S p q be a point in the first quadrant such that

2

2

1.

9

4

p

q

+

Two tangents are drawn from S to the ellipse, of which one meets the ellipse at one

end point of the minor axis and the other meets the ellipse at a point T in the fourth quadrant. Let

R be the vertex of the ellipse with positive x -coordinate and Obe the center of the ellipse. If the area of the triangle ORT

is 3 ,

2

then which of the following options is correct?

(A)

2,

3 3

q

p

=

=

(B)

2,

4 3

q

p

=

=

(C)

1,

5 3

q

p

=

=

(D)

1,

6 3

q

p

=

=

Answer: Here is a detailed answer to the two questions:

Question: JEE (Advanced) 2024

Paper 1

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SECTION 2 (Maximum Marks: 12)

This section contains THREE (03) questions.

Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).

For each question, choose the option(s) corresponding to (all) the correct answer(s).

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +4 ONLY if (all) the correct option(s) is(are) chosen;

Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;

Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of

which are correct;

Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;

Zero Marks

: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 2 In all other cases.

For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then

choosing ONLY (A), (B) and (D) will get +4 marks;

choosing ONLY (A) and (B) will get +2 marks;

choosing ONLY (A) and (D) will get +2 marks;

choosing ONLY (B) and (D) will get +2 marks;

choosing ONLY (A) will get +1 mark;

choosing ONLY (B) will get +1 mark;

choosing ONLY (D) will get +1 mark;

choosing no option (i.e. the question is unanswered) will get 0 marks; and

choosing any other combination of options will get 2 marks.

Q.5

Let

2 : ,

,

S

a

b

a b

=

+

(

)

1

1

2

:

n

T

n

=

+

, and

(

)

2

1

2

:

.

n

T

n

=

+

Then which of the following statements is (are) TRUE?

(A)

1

2

T

T

S

(B)

1

1

0, 2024

T

=

, where denotes the empty set.

(C)

(

)

2

2024,

T

(D) For any given ,

,

a b

(

)

(

)

(

)

(

)

cos

2

sin

2

a

b

i

a

b

+

+

+

if and only if

0,

b =

where

1

i =

.

Answer: The answer is (A), (B), and (D).

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Paper 1

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Q.6

Let

2 denote

.

Let

2

2

2

(, ,) : , ,

and

2

0 for all (,)

(0,0)

.

S

a b c

a b c

ax

bxy

cy

x y

=

+

+

Then which of the following statements is (are) TRUE?

(A)

7

2,

,6

2

S

(B) If

1

3, ,

,

12

b

S

then | 2 |

b < 1.

(C) For any given (

)

, ,

,

a b c

S

the system of linear equations

1

1

ax

by

bx

cy

+

=

+

=

has a unique solution.

(D) For any given (

)

, ,

,

a b c

S

the system of linear equations

(

1)

0

(

1)

0

a

x

by

bx

c

y

+

+

=

+

+

=

has a unique solution.

Q.7

Let

3 denote the three-dimensional space. Take two points

(1,2,3)

P =

and

(4,2,7).

Q =

Let

(

,)

dist X Y denote the distance between two points X and Y in

3. Let

(

)

(

)

2

2

3 :

(

,)

(

,

)

50

S

X

dist X P

dist X Q

=

=

and

(

)

(

)

2

2

3 :

(,

)

(,)

50 .

T

Y

dist Y Q

dist Y P

=

=

Then which of the following statements is (are) TRUE?

(A) There is a triangle whose area is 1 and all of whose vertices are from .

S

(B) There are two distinct points L and M in T such that each point on the line segment

LM is also in .

T

(C) There are infinitely many rectangles of perimeter 48, two of whose vertices are from S and

the other two vertices are from .

T

(D) There is a square of perimeter 48, two of whose vertices are from S and the other two vertices

are

from .

T

Answer: Here is a detailed answer to the question:

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Paper 1

Q.8

Let

3 2

a =

and

1/6

1

5

6

b =

. If ,x y

are such that

(

)

5

4

3

2

log

18

a

x

y

+

=

and

(

)

2

log

1080 ,

b

x

y

=

then 4

5

x

y

+

is equal to _____.

Q.9

Let

4

3

2

( )

f x

x

ax

bx

c

=

+

+

+

be a polynomial with real coefficients such that

(1)

9.

f

=

Suppose

that

3

i

is a root of the equation

3

2

4

3

2

0,

x

ax

bx

+

+

=

where

1

i =

. If

1

2

3

4

,

,

, and

are

all the roots of the equation

( )

0,

f x =

then

2

2

2

2

1

2

3

4

+

+

+

is equal to _____.

Q.10

Let = { = (

0

1

1

1

) , , , , {0, 1} and | | { 1, 1}}, where | | denotes the

determinant of . Then the number of elements in is _____.

Q.11

A group of 9students,

1

2

9

,

,

,

,

s s

s

is to be divided to form three teams

, , and

X Y

Z of sizes

2,3, and 4, respectively. Suppose that

1s cannot be selected for the team

,

X and

2s cannot be

selected for the team .

Y Then the number of ways to form such teams, is _____.

SECTION 3 (Maximum Marks: 24)

This section contains SIX (06) questions.

The answer to each question is a NON-NEGATIVE INTEGER.

For each question, enter the correct integer corresponding to the answer using the mouse and the on-

screen virtual numeric keypad in the place designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +4 If ONLY the correct integer is entered;

Zero Marks

: 0 In all other cases.

Answer: The answer is 12, 16, 15, 25, 36, 5.

Question: JEE (Advanced) 2024

Paper 1

6/10

Q.12

Let

1

1

,

OP

i

j

k OQ

i

j

k

=

+

+

= +

+

and

1

2

OR

i

j

k

= +

+

be three vectors, where

,

0

and O denotes the origin. If (

)

0

OP OQ

OR

=

and the point (,

,2)

lies on

the plane 3

3

0,

x

y

z

l

+

+ =

then the value of l is _____.

Q.13

Let X be a random variable, and let

(

)

P X

x

=

denote the probability that X takes the value .x

Suppose that the points (

)

, (

)

x P X

x

=

,

0,1,2,3,4,

x =

lie on a fixed straight line in the xy -plane,

and

(

)

0

P X

x

=

=

for all

0,1,2,3,4 .

x

If the mean of X is 5

2

, and the variance of X is

,

then the value of 24 is _____.

Answer: Here is the solution to the two-part question:

Question: JEE (Advanced) 2024

Paper 1

7/10

Q.14

Let and be the distinct roots of the equation

2

1

0.

x

x

+

=

Consider the set

1, ,

.

T

=

For a 3 3

matrix

(

)3 3 ,

ij

M

a

=

define

1

2

3

i

i

i

i

R

a

a

a

=

+

+

and

1

2

3

j

j

j

j

C

a

a

a

=

+

+

for

1,2,3

i =

and

1,2,3.

j =

Match each entry in List-I to the correct entry in List-II.

List-I

List-II

(P) The number of matrices

(

)3 3

ij

M

a

=

with

all entries in T such that

0

i

j

R

C

=

=

for all , ,

i j is

(1) 1

(Q) The number of symmetric matrices

(

)3 3

ij

M

a

=

with all entries in T such that

0 for all ,

j

C

j

=

is

(2) 12

(R) Let

(

)3 3

ij

M

a

=

be a skew symmetric

matrix such that

ij

a

T

for i

j

. Then

the number of elements in the set

12

23

: , ,

,

0

x

x

a

y

x y z

M

y

z

z

a

=

is

(3) infinite

(S) Let

(

)3 3

ij

M

a

=

be a matrix with all

entries in T such that

0 for

iR =

all .i

Then the absolute value of the determinant

of M is

(4) 6

(5) 0

The correct option is

(A) (P)

(4) (Q)

(2) (R)

(5) (S)

(1)

(B) (P)

(2) (Q)

(4) (R)

(1) (S)

(5)

(C) (P)

(2) (Q)

(4) (R)

(3) (S)

(5)

(D) (P)

(1) (Q)

(5) (R)

(3) (S)

(4)

SECTION 4 (Maximum Marks: 12)

This section contains FOUR (04) Matching List Sets.

Each set has ONE Multiple Choice Question.

Each set has TWO lists: List-I and List-II.

List-I has Four entries (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).

FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of

these four options satisfies the condition asked in the Multiple Choice Question.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +3 ONLY if the option corresponding to the correct combination is chosen;

Zero Marks

: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 1 In all other cases.

Answer: Here is a detailed answer to the question:

Question: JEE (Advanced) 2024

Paper 1

8/10

Q.15

Let the straight line

2

y

x

=

touch a circle with center (0,

), > 0,

and radius r at a point

1.

A

Let

1B be the point on the circle such that the line segment

1

1

A B is a diameter of the circle. Let

5

5.

r

+

=

+

Match each entry in List-I to the correct entry in List-II.

List-I

List-II

(P) equals

(1) (2,4)

(Q) r equals

(2) 5

(R)

1A equals

(3) (2,6)

(S)

1B equals

(4) 5

(5) (2,4)

The correct option is

(A) (P)

(4) (Q)

(2) (R)

(1) (S)

(3)

(B) (P)

(2) (Q)

(4) (R)

(1) (S)

(3)

(C) (P)

(4) (Q)

(2) (R)

(5) (S)

(3)

(D) (P)

(2) (Q)

(4) (R)

(3) (S)

(5)

Answer: The correct answer is Option B.

Question: JEE (Advanced) 2024

Paper 1

9/10

Q.16

Let

be such that the lines

1

11

21

29

:

1

2

3

x

y

z

L

+

+

+

=

=

and

2

16

11

4

:

3

2

x

y

z

L

+

+

+

=

=

intersect. Let

1R be the point of intersection of

1L and

2.

L Let

(0,0,0),

O =

and n denote a unit

normal vector to the plane containing both the lines

1L and

2.

L

Match each entry in List-I to the correct entry in List-II.

List-I

List-II

(P) equals

(1)

i

j

k

+

(Q) A possible choice for n is

(2)

3

2

(R)

1

OR equals

(3) 1

(S) A possible value of

1

OR n

is

(4) 1

2

1

6

6

6

i

j

k

+

(5)

2

3

The correct option is

(A) (P)

(3) (Q)

(4) (R)

(1) (S)

(2)

(B) (P)

(5) (Q)

(4) (R)

(1) (S)

(2)

(C) (P)

(3) (Q)

(4) (R)

(1) (S)

(5)

(D) (P)

(3) (Q)

(1) (R)

(4) (S)

(5)

Answer: The correct answer is Option D. Here is a detailed solution:

Question: JEE (Advanced) 2024

Paper 1

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Q.17

Let

:

f

and

:

g

be functions defined by

1

|

| sin

,

0,

( )

0,

0,

x x

x

f x

x

x

=

=

and

1

1 2 , 0

,

( )

2

0, otherwise .

x

x

g x

=

Let , , ,

.

a b c d

Define the function :

h

by

(

)

1

( )

( )

( )

( )

( ),

.

2

h x

a f x

b g x

g

x

c x

g x

d g x

x

=

+

+

+

+

Match each entry in List-I to the correct entry in List-II.

List-I

List-II

(P) If

0,

1,

0, and

0,

a

b

c

d

=

=

=

=

 then

(1) h is one-one.

(Q) If

1,

0,

0, and

0,

a

b

c

d

=

=

=

=

then

(2) h is onto.

(R) If

0,

0,

1, and

0,

a

b

c

d

=

=

=

=

then

(3) h is differentiable on

.

(S) If

0,

0,

0, and

1,

a

b

c

d

=

=

=

=

then

(4) the range of h is

0,1 .

(5) the range of h is

0,1 .

The correct option is

(A) (P)

(4) (Q)

(3) (R)

(1) (S)

(2)

(B) (P)

(5) (Q)

(2) (R)

(4) (S)

(3)

(C) (P)

(5) (Q)

(3) (R)

(2) (S)

(4)

(D) (P)

(4) (Q)

(2) (R)

(1) (S)

(3)

END OF THE QUESTION PAPER

Answer: The correct answer is Option (B).

Question: JEE (Advanced) 2024

Paper 1

SECTION 1 (Maximum Marks: 12)

This section contains FOUR (04) questions.

Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct

answer.

For each question, choose the option corresponding to the correct answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;

Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 1 In all other cases.

Q.1

A dimensionless quantity is constructed in terms of electronic charge , permittivity of free space 0, Planck s constant , and speed of light . If the dimensionless quantity is written as 0 and is a non-zero integer, then (, , ,) is given by

(A) (2 , , ,)

(B) (, , 2 ,)

(C) (, , , 2)

(D) (2 , , 2 , 2)

Q.2

An infinitely long wire, located on the -axis, carries a current along the + -direction and produces the magnetic field . The magnitude of the line integral along a straight line from the point (3 , , 0) to (, , 0) is given by

[0 is the magnetic permeability of free space.]

(A) 7 0 /24

(B) 7 0 /12

(C) 0 /8

(D) 0 /6

Q.3

Two beads, each with charge and mass , are on a horizontal, frictionless, non-conducting, circular hoop of radius . One of the beads is glued to the hoop at some point, while the other one performs small oscillations about its equilibrium position along the hoop. The square of the angular frequency of the small oscillations is given by

[0 is the permittivity of free space.]

(A) 2/(4 0 3)

(B) 2/(32 0 3)

(C) 2/(8 0 3)

(D) 2/(16 0 3)

Q.4

A block of mass 5 kg moves along the x-direction subject to the force = (20 + 10) N, with the value of in metre. At time = 0 s, it is at rest at position = 1 m. The position and momentum of the block at = (/4) s are

(A) 0.5 m, 5 kg m/s

(B) 0.5 m, 0 kg m/s

(C) 0.5 m, 5 kg m/s

(D) 1 m, 5 kg m/s

Physics

Answer: Here is a detailed answer to the questions provided:

Question: JEE (Advanced) 2024

Paper 1

SECTION 2 (Maximum Marks: 12)

This section contains THREE (03) questions.

Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)

is(are) correct answer(s).

For each question, choose the option(s) corresponding to (all) the correct answer(s).

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +4 ONLY if (all) the correct option(s) is(are) chosen;

Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;

Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of

which are correct;

Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;

Zero Marks

: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 2 In all other cases.

For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then

choosing ONLY (A), (B) and (D) will get +4 marks;

choosing ONLY (A) and (B) will get +2 marks;

choosing ONLY (A) and (D) will get +2 marks;

choosing ONLY (B) and (D) will get +2 marks;

choosing ONLY (A) will get +1 mark;

choosing ONLY (B) will get +1 mark;

choosing ONLY (D) will get +1 mark;

choosing no option (i.e. the question is unanswered) will get 0 marks; and

choosing any other combination of options will get 2 marks.

Q.5

A particle of mass is moving in a circular orbit under the influence of the central force ( ) = , corresponding to the potential energy ( ) = 2/2, where is a positive force constant and is the radial distance from the origin. According to the Bohr s quantization rule, the angular momentum of the particle is given by = , where = /(2), is the Planck s constant, and a positive integer. If and are the speed and total energy of the particle, respectively, then which of the following expression(s) is(are) correct?

(A) 2 = 1

(B) 2 =

3

(C)

2 =

(D) =

2

Answer: The correct answer is option (B).

Question: JEE (Advanced) 2024

3/8

Q.6

Two uniform strings of mass per unit length and 4 , and length and 2 , respectively, are joined at point O, and tied at two fixed ends P and Q, as shown in the figure. The strings are under a uniform tension . If we define the frequency 0 =

1

2

, which of the following statement(s) is(are) correct?

(A) With a node at O, the minimum frequency of vibration of the composite string is 0.

(B) With an antinode at O, the minimum frequency of vibration of the composite string is 2 0.

(C) When the composite string vibrates at the minimum frequency with a node at O, it has 6 nodes, including the end nodes.

(D) No vibrational mode with an antinode at O is possible for the composite string.

Q.7

A glass beaker has a solid, plano-convex base of refractive index 1.60, as shown in the figure. The

radius of curvature of the convex surface (SPU) is 9 cm, while the planar surface (STU) acts as a mirror. This beaker is filled with a liquid of refractive index up to the level QPR. If the image of a point object O at a height of (OT in the figure) is formed onto itself, then, which of the following option(s) is(are) correct?

(A) For = 1.42, = 50 cm.

(B) For = 1.35, = 36 cm.

(C) For = 1.45, = 65 cm.

(D) For = 1.48, = 85 cm.

Answer: Here are the solutions to the two problems:

Question: JEE (Advanced) 2024

Paper 1

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Q.8

The specific heat capacity of a substance is temperature dependent and is given by the formula = , where is a constant of suitable dimensions in SI units, and is the absolute temperature. If the heat required to raise the temperature of 1 kg of the substance from 73 C to 27 C is , the value of is _____.

[Given: 0 K = 273 C.]

Q.9

A disc of mass and radius is free to rotate about its vertical axis as shown in the figure. A battery operated motor of negligible mass is fixed to this disc at a point on its circumference. Another disc of the same mass and radius /2 is fixed to the motor s thin shaft. Initially, both the discs are at rest. The motor is switched on so that the smaller disc rotates at a uniform angular speed . If the angular speed at which the large disc rotates is / , then the value of is _____.

Q.10

A point source S emits unpolarized light uniformly in all directions. At two points A and B, the ratio = / of the intensities of light is 2. If a set of two polaroids having 45 angle between their pass-axes is placed just before point B, then the new value of will be _____.

SECTION 3 (Maximum Marks: 24)

This section contains SIX (06) questions.

The answer to each question is a NON-NEGATIVE INTEGER.

For each question, enter the correct integer corresponding to the answer using the mouse and the on-
screen virtual numeric keypad in the place designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +4 If ONLY the correct integer is entered;

Zero Marks

: 0 In all other cases.

Answer: The answer is 3 4 6.

Question: JEE (Advanced) 2024

Paper 1

Q.11

A source (S) of sound has frequency 240 Hz. When the observer (O) and the source move towards each other at a speed with respect to the ground (as shown in Case 1 in the figure), the observer measures the frequency of the sound to be 288 Hz. However, when the observer and the source move away from each other at the same speed with respect to the ground (as shown in Case 2 in the figure), the observer measures the frequency of sound to be Hz. The value of is _____.

Q.12

Two large, identical water tanks, 1 and 2, kept on the top of a building of height , are filled with water up to height in each tank. Both the tanks contain an identical hole of small radius on their sides, close to their bottom. A pipe of the same internal radius as that of the hole is connected to tank 2, and the pipe ends at the ground level. When the water flows from the tanks 1 and 2 through the holes, the times taken to empty the tanks are 1 and 2, respectively. If = (
16
9) , then the
ratio 1/ 2 is _____.

Q.13

A thin uniform rod of length and certain mass is kept on a frictionless horizontal table with a

massless string of length fixed to one end (top view is shown in the figure). The other end of the string is pivoted to a point O. If a horizontal impulse is imparted to the rod at a distance = / from the mid-point of the rod (see figure), then the rod and string revolve together around the point O, with the rod remaining aligned with the string. In such a case, the value of is _____.

Answer: Here are the solutions to the questions:

Question: JEE (Advanced) 2024

Paper 1

6/8

Q.14

One mole of a monatomic ideal gas undergoes the cyclic process J K L M J, as shown in the P-T diagram.

Match the quantities mentioned in List-I with their values in List-II and choose the correct option.

[is the gas constant.]

List-I

List-II

(P) Work done in the complete cyclic process

(1) 0 4 0 ln 2

(Q) Change in the internal energy of the gas in the

process JK

(2) 0

(R) Heat given to the gas in the process KL

(3) 3 0

(S) Change in the internal energy of the gas in the

process MJ

(4) 2 0 ln 2

(5) 3 0 ln 2

(A) P 1; Q 3; R 5; S 4

(B) P 4; Q 3; R 5; S 2

(C) P 4; Q 1; R 2; S 2

(D) P 2; Q 5; R 3; S 4

SECTION 4 (Maximum Marks: 12)

This section contains FOUR (04) Matching List Sets.

Each set has ONE Multiple Choice Question.

Each set has TWO lists: List-I and List-II.

List-I has Four entries (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).

FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of

these four options satisfies the condition asked in the Multiple Choice Question.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +3 ONLY if the option corresponding to the correct combination is chosen;

Zero Marks

: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 1 In all other cases.

Answer: Here is a step-by-step solution to the problem:

Question: JEE (Advanced) 2024

Paper 1

Q.15

Four identical thin, square metal sheets, 1, 2, 3 and 4, each of side are kept parallel to each other with equal distance ( ) between them, as shown in the figure. Let 0 = 0 2/ , where 0 is the permittivity of free space.

Match the quantities mentioned in List-I with their values in List-II and choose the correct option.

List-I

List-II

(P) The capacitance between 1 and 4, with 2 and 3 not connected, is

(1) 3 0

(Q) The capacitance between 1 and 4, with 2 shorted to 3, is

(2) 0/2

(R) The capacitance between 1 and 3, with 2 shorted to 4, is

(3) 0/3

(S) The capacitance between 1 and 2, with 3 shorted to 1, and 2 shorted to 4, is

(4) 2 0/3

(5) 2 0

(A) P 3; Q 2; R 4; S 5

(B) P 2; Q 3; R 2; S 1

(C) P 3; Q 2; R 4; S 1

(D) P 3; Q 2; R 2; S 5

Q.16

A light ray is incident on the surface of a sphere of refractive index at an angle of incidence 0. The ray partially refracts into the sphere with angle of refraction 0 and then partly reflects from the back surface. The reflected ray then emerges out of the sphere after a partial refraction. The total angle of deviation of the emergent ray with respect to the incident ray is . Match the quantities mentioned in List-I with their values in List-II and choose the correct option.

List-I

List-II

(P) If = 2 and = 180 , then all the

possible values of 0 will be

(1) 30 and 0

(Q) If = 3 and = 180 , then all the

possible values of 0 will be

(2) 60 and 0

(R) If = 3 and = 180 , then all the

possible values of 0 will be

(3) 45 and 0

(S) If = 2 and 0 = 45 , then all the

possible values of will be

(4) 150

(5) 0

(A) P 5; Q 2; R 1; S 4

(B) P 5; Q 1; R 2; S 4

(C) P 3; Q 2; R 1; S 4

(D) P 3; Q 1; R 2; S 5

Answer: Here are the solutions to the two problems:

Question: JEE (Advanced) 2024

Paper 1

8/8

Q.17

The circuit shown in the figure contains an inductor , a capacitor 0, a resistor 0 and an ideal battery. The circuit also contains two keys K1 and K2. Initially, both the keys are open and there is no charge on the capacitor. At an instant, key K1 is closed and immediately after this the current in 0 is found to be 1. After a long time, the current attains a steady state value 2. Thereafter, K2 is closed and simultaneously K1 is opened and the voltage across 0 oscillates with amplitude 0 and angular frequency 0.

Match the quantities mentioned in List-I with their values in List-II and choose the correct option.

List-I

List-II

(P) The value of 1 in Ampere is

(1) 0

(Q) The value of 2 in Ampere is

(2) 2

(R) The value of 0 in kilo-radians/s is

(3) 4

(S) The value of 0 in Volt is

(4) 20

(5) 200

(A) P 1; Q 3; R 2; S 5

(B) P 1; Q 2; R 3; S 5

(C) P 1; Q 3; R 2; S 4

(D) P 2; Q 5; R 3; S 4

END OF THE QUESTION PAPER

Answer: The answer is (C) P-1, Q-3, R-2, S-4.

Question: JEE (Advanced) 2024

Paper 1

1/12

SECTION 1 (Maximum Marks: 12)

This section contains FOUR (04) questions.

Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is the correct

answer.

For each question, choose the option corresponding to the correct answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen;

Zero Marks

: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 1 In all other cases.

Q.1

A closed vessel contains 10 g of an ideal gas X at 300 K, which exerts 2 atm pressure. At the same temperature, 80 g of another ideal gas Y is added to it and the pressure becomes 6 atm. The ratio of root mean square velocities of X and Y at 300 K is

(A) 2 2 3

(B) 2 2 1

(C) 1 2

(D) 2 1

Q.2

At room temperature, disproportionation of an aqueous solution of in situ generated nitrous acid (HNO2) gives the species

(A) H3O+, NO3 and NO

(B) H3O+, NO3 and NO2

(C) H3O+, NO and NO2

(D) H3O+, NO3 and N2O

Chemistry

Answer: The answer is (C) H3O+, NO, and NO2.

Question: JEE (Advanced) 2024

Paper 1

2/12

Q.3

Aspartame, an artificial sweetener, is a dipeptide aspartyl phenylalanine methyl ester. The structure

of aspartame is

Structures of phenylalanine and aspartic acid are given below.

(A)

(B)

(C)

(D)

Q.4

Among the following options, select the option in which each complex in Set-I shows geometrical isomerism and the two complexes in Set-II are ionization isomers of each other.

[en = H2NCH2CH2NH2]

(A) Set-I: [Ni(CO)4] and [PdCl2(PPh3)2]

Set-II: [Co(NH3)5Cl]SO4 and [Co(NH3)5(SO4)]Cl

(B) Set-I: [Co(en)(NH3)2Cl2] and [PdCl2(PPh3)2]

Set-II: [Co(NH3)6][Cr(CN)6] and [Cr(NH3)6][Co(CN)6]

(C) Set-I: [Co(NH3)3(NO2)3] and [Co(en)2Cl2]

Set-II: [Co(NH3)5Cl]SO4 and [Co(NH3)5(SO4)]Cl

(D) Set-I: [Cr(NH3)5Cl]Cl2 and [Co(en)(NH3)2Cl2]

Set-II: [Cr(H2O)6]Cl3 and [Cr(H2O)5Cl]Cl2 H2O

Answer: The answer is:

Question: JEE (Advanced) 2024

Paper 1

SECTION 2 (Maximum Marks: 12)

This section contains THREE (03) questions.

Each question has FOUR options (A), (B), (C) and (D). ONE OR MORE THAN ONE of these four option(s)
is(are) correct answer(s).

For each question, choose the option(s) corresponding to (all) the correct answer(s).

Answer to each question will be evaluated according to the following marking scheme:
Full Marks
: +4 ONLY if (all) the correct option(s) is(are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of

which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks
: 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : 2 In all other cases.

For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
choosing ONLY (A), (B) and (D) will get +4 marks;
choosing ONLY (A) and (B) will get +2 marks;
choosing ONLY (A) and (D) will get +2 marks;

choosing ONLY (B) and (D) will get +2 marks;

choosing ONLY (A) will get +1 mark;

choosing ONLY (B) will get +1 mark;

choosing ONLY (D) will get +1 mark;

choosing no option (i.e. the question is unanswered) will get 0 marks; and

choosing any other combination of options will get 2 marks.

Q.5

Among the following, the correct statement(s) for electrons in an atom is(are)

(A) Uncertainty principle rules out the existence of definite paths for electrons.

(B) The energy of an electron in 2s orbital of an atom is lower than the energy of an electron that is infinitely far away from the nucleus.

(C) According to Bohr s model, the most negative energy value for an electron is given by n = 1, which corresponds to the most stable orbit.

(D) According to Bohr s model, the magnitude of velocity of electrons increases with increase in values of n.

Answer: The correct answer is (A), (B), and (C).

Question: JEE (Advanced) 2024

Paper 1

Q.6

Reaction of iso-propylbenzene with O_2 followed by the treatment with H_3O^+ forms phenol and a by-product P. Reaction of P with 3 equivalents of Cl_2 gives compound Q. Treatment of Q with $Ca(OH)_2$ produces compound R and calcium salt S.

The correct statement(s) regarding P, Q, R and S is(are)

(A) Reaction of P with R in the presence of KOH followed by acidification gives

(B) Reaction of R with O_2 in the presence of light gives phosgene gas

(C) Q reacts with aqueous NaOH to produce Cl_3CCH_2OH and $Cl_3CCOONa$

(D) S on heating gives P

Q.7

The option(s) in which at least three molecules follow Octet Rule is(are)

(A) CO_2, C_2H_4, NO and HCl

(B) NO_2, O_3, HCl and H_2SO_4

(C) BCl_3, NO, NO_2 and H_2SO_4

(D) CO_2, BCl_3, O_3 and C_2H_4

Answer: Here is a detailed answer for the questions provided:

Question: JEE (Advanced) 2024

Paper 1

Q.8

Consider the following volume temperature (V T) diagram for the expansion of 5 moles of an ideal monoatomic gas.

Considering only P-V work is involved, the total change in enthalpy (in Joule) for the transformation of state in the sequence X Y Z is _____.

[Use the given data: Molar heat capacity of the gas for the given temperature range, CV, m = 12 J K 1 1 mol 1 and gas constant, R = 8.3 J K 1 mol 1]

SECTION 3 (Maximum Marks: 24)

This section contains SIX (06) questions.

The answer to each question is a NON-NEGATIVE INTEGER.

For each question, enter the correct integer corresponding to the answer using the mouse and the on-
screen virtual numeric keypad in the place designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +4 If ONLY the correct integer is entered;

Zero Marks

: 0 In all other cases.

Answer: The total change in enthalpy for the transformation of state in the sequence X Y Z is **2640 J**.

Question: JEE (Advanced) 2024

Paper 1

Q.9

Consider the following reaction,

( )

( )

( )

( )

2

2

2

2H

g + 2NO g

N

g + 2H

g

O

which follows the mechanism given below:

( )

( )

(

)

1

1

2

2

2NO g

N O

g fast equlibrium

k

k

( )

( )

( )

( )

(

)

2

2

2

2

2

2

N O

g + H

g

N O g + H O g slow reaction

k

( )

( )

( )

( )

(

)

3

2

2

2

2

N O g + H

g

N

g + H O g fast reaction

k

The order of the reaction is _____.

Q.10

Complete reaction of acetaldehyde with excess formaldehyde, upon heating with conc. NaOH solution, gives P and Q. Compound P does not give Tollens test, whereas Q on acidification gives positive Tollens test. Treatment of P with excess cyclohexanone in the presence of catalytic amount of p-toluenesulfonic acid (PTSA) gives product R.

Sum of the number of methylene groups (-CH2-) and oxygen atoms in R is _____.

Q.11

Among V(CO)6, Cr(CO)5, Cu(CO)3, Mn(CO)5, Fe(CO)5, [Co(CO)3]3 , [Cr(CO)4]4 , and Ir(CO)3, the total number of species isoelectronic with Ni(CO)4 is _____.

[Given, atomic number: V = 23, Cr = 24, Mn = 25, Fe = 26, Co = 27, Ni = 28, Cu = 29, Ir = 77]

Answer: Here are the answers to the questions provided:

Question: JEE (Advanced) 2024

Paper 1

Q.12

In the following reaction sequence, the major product P is formed.

Glycerol reacts completely with excess P in the presence of an acid catalyst to form Q. Reaction of Q with excess NaOH followed by the treatment with $CaCl_2$ yields Ca-soap R, quantitatively.

Starting with one mole of Q, the amount of R produced in gram is _____.

[Given, atomic weight: H = 1, C = 12, N = 14, O = 16, Na = 23, Cl = 35, Ca = 40]

Q.13

Among the following complexes, the total number of diamagnetic species is _____.

$[Mn(NH_3)_6]^{3+}$, $[MnCl_6]^{3}$, $[FeF_6]^{3}$, $[CoF_6]^{3}$, $[Fe(NH_3)_6]^{3+}$, and $[Co(en)_3]^{3+}$

[Given, atomic number: Mn = 25, Fe = 26, Co = 27;

en = $H_2NCH_2CH_2NH_2$]

Answer: For question 12, the correct answer is 342 grams.

Question: JEE (Advanced) 2024

Paper 1

SECTION 4 (Maximum Marks: 12)

This section contains FOUR (04) Matching List Sets.

Each set has ONE Multiple Choice Question.

Each set has TWO lists: List-I and List-II.

List-I has Four entries (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).

FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of

these four options satisfies the condition asked in the Multiple Choice Question.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks

: +3 ONLY if the option corresponding to the correct combination is chosen;

Zero Marks

: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : 1 In all other cases.

Answer: Here is a detailed answer to the question:

Question: JEE (Advanced) 2024

Paper 1

9/12

Q.14

In a conductometric titration, small volume of titrant of higher concentration is added stepwise to a larger volume of titrate of much lower concentration, and the conductance is measured after each addition.

The limiting ionic conductivity (0) values (in mS m2 mol 1) for different ions in aqueous solutions are given below:

Ions Ag+

K+

Na+

H+

NO3

Cl

SO4

2 OH

CH3COO

0

6.2

7.4

5.0

35.0

7.2

7.6

16.0

19.9

4.1

For different combinations of titrates and titrants given in List-I, the graphs of conductance versus volume of titrant are given in List-II.

Match each entry in List-I with the appropriate entry in List-II and choose the correct option.

List-I

List-II

(P) Titrate: KCl

Titrant: $AgNO_3$

(1)

(Q) Titrate: $AgNO_3$

Titrant: KCl

(2)

(R) Titrate: NaOH

Titrant: HCl

(3)

(S) Titrate: NaOH

Titrant: CH_3COOH

(4)

(5)

(A) P-4, Q-3, R-2, S-5

(B) P-2, Q-4, R-3, S-1

(C) P-3, Q-4, R-2, S-5

(D) P-4, Q-3, R-2, S-1

Answer: The correct answer is (C) P-3, Q-4, R-2, S-5.

Question: JEE (Advanced) 2024

Paper 1

10/12

Q.15

Based on VSEPR model, match the xenon compounds given in List-I with the corresponding geometries and the number of lone pairs on xenon given in List-II and choose the correct option.

List-I

List-II

(P) XeF2

(1) Trigonal bipyramidal and two lone pair of electrons

(Q) XeF4

(2) Tetrahedral and one lone pair of electrons

(R) XeO3

(3) Octahedral and two lone pair of electrons

(S) XeO3F2

(4) Trigonal bipyramidal and no lone pair of electrons

(5) Trigonal bipyramidal and three lone pair of electrons

(A) P-5, Q-2, R-3, S-1

(B) P-5, Q-3, R-2, S-4

(C) P-4, Q-3, R-2, S-1

(D) P-4, Q-2, R-5, S-3

Answer: The answer is D) P-4, Q-2, R-5, S-3.

Question: JEE (Advanced) 2024

Paper 1

11/12

Q.16

List-I contains various reaction sequences and List-II contains the possible products. Match each entry in List-I with the appropriate entry in List-II and choose the correct option.

List-I

List-II

(P)

(1)

(Q)

(2)

(R)

(3)

(S)

(4)

(5)

(A) P-3, Q-5, R-4, S-1

(B) P-3, Q-2, R-4, S-1

(C) P-3, Q-5, R-1, S-4

(D) P-5, Q-2, R-4, S-1

Answer: The correct answer is (B) P-3, Q-2, R-4, S-1.

Question: JEE (Advanced) 2024

Paper 1

Q.17

List-I contains various reaction sequences and List-II contains different phenolic compounds.

Match each entry in List-I with the appropriate entry in List-II and choose the correct option.

List-I

List-II

(P)

(1)

(Q)

(2)

(R)

(3)

(S)

(4)

(5)

(A) P-2, Q-3, R-4, S-5

(B) P-2, Q-3, R-5, S-1

(C) P-3, Q-5, R-4, S-1

(D) P-3, Q-2, R-5, S-4

END OF THE QUESTION PAPER

Answer: The correct answer is Option C: P-3, Q-5, R-4, S-1.