Ductile fracture is characterized by:
- shiny appearance
- cup and cone structure
- with no plastic deformation
- subsurface cracks

Cast iron known for its -------------- character.
- Brittle
- Ductile
- Toughness
- Low melting point

The sample preparation process by which the structural features of a metallic sample is revealed in optical microscopy is known as:
- implantation
- etching
- sputtering
- lithography

For a cylindrical shaft of length 'L' and radius 'r', if torque 'M' operates then shear stress is given by:
- \( \frac{2M}{\pi r^3} \)
- \( \frac{2M}{\pi r^2} \)
- \( \frac{2M}{\pi r^3} \)
- \( \frac{2}{\pi M r^2} \)

Among the following bonding types which exhibit high melting point:
- covalent
- secondary
- metallic
- ionic
For underground pipelines the commonly used joint is:

- sleeve joint
- flange
- expansion joint
- coupling

In a four stroke cycle, the minimum temperature inside the engine cylinder occurs at the:

- end of exhaust stroke
- beginning of exhaust stroke
- beginning of suction stroke
- end of suction stroke

The hardest material among the following:

- sapphire
- gypsum
- apatite
- fluorite

Generally used moderator in the nuclear power plant is:

- beryllium
- cadmium
- lead
- graphite

The bond formed by the transfer of one electron to the other is known as:

- ionic
- metallic
- hydrogen
- covalent

In non-destructive testing, the dye penetrant test is usually carried out to check the defects.
Which among the following notation represents the family of directions in a crystal?
- (111)
- <111>
- [111]
- {111}

Which among the following has highest percentage of ionic character?
- MgO
- ZnS
- SiC
- NaCl

The process by which consolidation of powder into solid dense mass is known as:-
- sintering
- diffusion
- infiltration
- pressing

Which one among the following is not converted into non pollutant in a catalytic converter?
- unburnt hydrocarbon
- oxides of nitrogen
- carbon monoxide
- sulphur

A completely aligned fiber reinforced composite consist – 40 vol% fiber with modulus of elasticity 69 GPa and 60 vol% matrix with the modulus of 3.4 GPa. The modulus of the composite is:-
- 15 GPa
When a material is stressed, the generation of electricity is known as:
- piezoresistivity
- ferroelectricity
- thermoelectricity
- piezoelectricity

On increasing the temperature:
- the resistivity of a metal and a semiconductor increases
- the resistivity of a metal and a semiconductor decreases
- the resistivity of a metal increases while for a semiconductor decreases
- the resistivity of a metal decreases while for a semiconductor increases

Identify the statement which is TRUE with respect to nanomaterials.
- For unit mass surface energy of the nanostructures are lower than the micron sized particles
- Surface energy of the nanostructures are zero
- For nanomaterials surface area to volume ratio is high
- For nanomaterials total number of atoms present on the surface is low

Permanent magnetic moment in the absence of electric field is known as:
- ferromagnetism
- diamagnetism
- paramagnetism
- giant magneto resistance

Deuteron has only one bound state with spin parity $1^+$, isospin 0 and electric quadrupole moment 0.286 efm$^2$. These data suggest that the nuclear forces are having:
- only spin and isospin dependence
- spin dependence along with tensor components
spin dependence but no tensor components
- Ono spin dependence and no tensor components

22 of 100
125 PU_2015_305
The Hall coefficient, $RH$, of sodium depends on:-
- The charge carrier density only
- The effective charge carrier mass and carrier density
- The charge carrier density and relaxation time
- The effective charge carrier mass

23 of 100
135 PU_2015_305
The ground state wave function of deuteron is in a superposition of s and d states. Which of the following is NOT true as a consequence?
- It has a non-zero quadruple moment
- The neutron-proton potential is non-central
- The Hamiltonian does not conserve the total angular momentum
- The orbital wavefunction is not spherically symmetric

24 of 100
131 PU_2015_305
A magnetic field sensor based on the Hall Effect is to be fabricated by implanting As into a Si film of thickness 1 μm. The specifications require a magnetic field sensitivity of 500 mV/Tesla at an excitation current of 1 mA. The implantation dose is to be adjusted such that the average carrier density, after activation, is:
- $1.25 \times 10^{22} \text{m}^{-3}$
- $1.25 \times 10^{20} \text{m}^{-3}$
- $4.1 \times 10^{21} \text{m}^{-3}$
- $4.1 \times 10^{20} \text{m}^{-3}$

25 of 100
127 PU_2015_305
For a three-dimensional crystal having $N$ primitive unit cells with a basis of $p$ atoms, the number of optical branches is:
- $3p$
- $3p - 3$
- $3N - 3p$
- 3

26 of 100
143 PU_2015_305
A cavity contains blackbody radiation in equilibrium at temperature $T$. The specific heat per unit volume of the photon gas in the cavity is of the form $C_V = \gamma T^3$, where $\gamma$ is a constant. The cavity is expanded to twice
its original volume and then allowed to equilibrate at the same temperature T. The new internal energy per unit volume is:-

- $\gamma T^4$
- $\gamma T^4$
- $2\gamma T^4$
- $4\gamma T^4$

**27 of 100**
139 PU_2015_305
Choose the CORRECT statement from the following?
- Electron does not interact through weak interaction
- Neutron interacts through electromagnetic interaction
- Neutrino interacts through weak and electromagnetic interaction
- Quark interacts through strong interaction but not through weak interaction

**28 of 100**
141 PU_2015_305
A proton is confined to a cubic box, whose sides have length $10^{-12}$ m. What is the minimum kinetic energy of the proton? The mass of proton is $1.67 \times 10^{-27}$ kg and Planck's constant is $6.63 \times 10^{-34}$ Js.

- $3.3 \times 10^{-17}$ J
- $9.9 \times 10^{-17}$ J
- $6.6 \times 10^{-17}$ J
- $1.1 \times 10^{-17}$ J

**29 of 100**
129 PU_2015_305
The excitations of a three-dimensional solid are bosonic in nature with their frequency $\omega$ and wave-number $k$ are related by $\omega \propto k^2$ in the large wavelength limit. If the chemical potential is zero, the behaviour of the specific heat of the system at low temperature is proportional to:-

- $T^{3/2}$
- $T^{1/2}$
- $T^3$
- $T$

**30 of 100**
133 PU_2015_305
The pressure of a nonrelativistic free Fermi gas in three-dimensions depends, at $T = 0$, on the density of fermions $n$ as:-

- $n^{4/3}$
- $n^{2/3}$
- $n^{5/3}$
- $n^{1/3}$
Consider a Maxwellian distribution of the velocity of the molecules of an ideal gas. Let $V_{mp}$ and $V_{rms}$ denote the most probable velocity and the root mean square velocity, respectively. The magnitude of the ratio $V_{mp}/V_{rms}$ is:

- $2/3$
- $(2/3)^{1/2}$
- $1$
- $3/2$

A gas of $N$ non-interacting particles is in thermal equilibrium at temperature $T$. Each particle can be in any of the possible non-degenerate states of energy $0, 2\epsilon$ and $4\epsilon$. The average energy per particle of the gas, when $\beta\epsilon << 1$, is:

- $\epsilon$
- $2\epsilon$
- $3\epsilon$
- $2\epsilon / 3$

Bose condensation occurs in liquid He$^4$ kept at ambient pressure at 2.17 K. At which temperature will Bose condensation occur in He$^4$ in gaseous state, the density of which is 1000 times smaller than that of liquid He$^4$? (Assume that it is a perfect Bose gas.)

- 21.7 mK
- 21.7 \(\mu\)K
- 2.17 \(\mu\)K
- 2.17 mK

Gas molecules of mass $m$ are confined in a cylinder of radius $R$ and height $L$ (with $R >> L$) kept vertically in the Earth's gravitational field. The average energy of the gas at low temperatures (such that $mgL >> kBT$) is given by:

- $2NkBT$
- $NkBT/2$
- $5NkBT$
- $3NkBT/2$

Let $\Delta W$ be the work done in a quasistatic reversible thermodynamic process. Which of the following statements about $\Delta W$ is correct?

- $\Delta W$ is always a perfect differential
\[ \Delta W \text{ is a perfect differential if the process is adiabatic} \]
\[ \Delta W \text{ is a perfect differential if the process is isothermal} \]
\[ \Delta W \text{ cannot be a perfect differential} \]

36 of 100
235 PU_2015_305
A system of non-interacting spin-1/2 charged particles are placed in an external magnetic field. At low temperature \( T \), the leading behavior of the excess energy above the ground state energy, depends on \( T \) as: ( \( c \) is a constant)
\[ e^c / T \]
\[ cT \]
\[ cT^3 \]
\[ c \text{ (is independent of } T \) \]

37 of 100
271 PU_2015_305
If the peak output voltage of a full wave rectifier is 10 V, its d.c. voltage is:
\[ 3.18 \text{ V} \]
\[ 6.36 \text{ V} \]
\[ 10.0 \text{ V} \]
\[ 7.07 \text{ V} \]

38 of 100
269 PU_2015_305
The pressure of a nonrelativistic free Fermi gas in three-dimensions depends, at \( T = 0 \), on the density of fermions \( n \) as:
\[ n^{4/3} \]
\[ n^{2/3} \]
\[ n^{5/3} \]

39 of 100
273 PU_2015_305
For the set of all Lorentz transformations with velocities along the x-axis consider the two statements given below:

P: If \( L \) is a Lorentz transformation then, \( L^{-1} \) is also a Lorentz transformation. Q: If \( L1 \) and \( L2 \) are Lorentz transformations then, \( L1L2 \) is necessarily a Lorentz transformation.

Choose the correct option.
\[ P \text{ is true and } Q \text{ is false} \]
\[ P \text{ is false and } Q \text{ is true} \]
\[ Both \ P \text{ and } Q \text{ are true} \]
\[ Both \ P \text{ and } Q \text{ are false} \]
Two particles each of rest mass $m$ collide head-on and stick together. Before collision, the speed of each mass was 0.6 times the speed of light in free space. The mass of the final entity is:

- $2m$
- $5m/2$
- $25m/8$
- $5m/4$

Antibodies that recognize only one epitope derived from a single clone is called:

- Bivalent antibodies
- Polyclonal antibodies
- Monoclonal antibodies
- Monovalent antibodies

Relative amount of A, T, G and C in DNA were measured first by:

- Ramachandran
- Watson and Crick
- Erwing Chargaff
- Peterson

The enzymes used in polymerase chain reaction is:

- Taq DNA polymerase
- Polymerase III
- DNA ligase
- RNA polymerase

Guanosine nucleotide is held by the cytosine nucleotide by the number of H-bonds:

- 4
- 2
- 1
- 3
The first reaction involved in the carbohydrate metabolism is:
- Formation of Acety Co-A
- Carboxylation
- Phosphorylation
- Hydrogenation

In the melting point curve of DNA, Tm increases with increasing:
- A + G content
- G + C content
- A + C content
- G + T content

Suitable organism for use in recombinant vaccine is:
- Influenza virus
- Vaccina virus
- Small pox virus
- Poliomyelitus virus

The process of synthesis of protein from RNA is called:
- Isolation
- Replication
- Transcription
- Translation

When the idiotopes are used as vaccine to mimic antigen, the vaccine is known as:
- Synthetic vaccine
- Recombinant vaccine
- Subunit vaccine
- Anti-idiotypic vaccine
The technique of transfer of DNA molecules separated by gel electrophoresis to the nitrocellulose or nylon membrane is called:
- Eastern blot
- Northern blot
- Southern blot
- Western blot

Conjugal transfer of gene takes place in Bacteria by:
- Fimbriae
- Sexpili
- Polymerized molecule
- Flagellae

The pH of a buffer to be used for the separation of lysine and histidine in cation exchange column is:
- 2
- 4
- 8
- 12

The lethal gene ratio is:
- 2:1
- 4:1
- 8:1
- 1:1

α-helix is disrupted by certain aminoacids like:
- Arginine
- Proline
- Histidine
- Lysine
The recombinant DNA based human vaccine commercially available against:
- Leprosy
- HIV
- Tuberculosis
- Hepatitis B

The neutral aminoacid is:
- Proline
- Histidine
- Leucine
- Serine

All t-RNA molecules have a common CCA sequence at the:
- 5' 3' terminal
- 3' terminal
- 5' terminal
- 3'5' terminal

Keratin is synthesized from:
- Glycine
- Proline
- Serine
- Methionine

The shape of natural DNA strands cannot be:
- Hairpin
- Interlocked
- Circular
- Linear
The gene coding for VP1 is cloned in:

- pUC 18
- pUC 19
- pMB 9
- pBR 322

If in a frequently distribution, the mean and median are 21 and 22 respectively, then its mode is approximately:

- 20.5
- 22.0
- 25.5
- 24.0

The compound interest on Rs. 30,000 at 7% per annum is Rs. 4347. The period (in years) is:

- 3
- 2
- 4
- 2.5

In the first 10 overs of a cricket game, the run rate was only 3.2. What should be the run rate in the remaining 40 overs to reach the target of 282 runs?

- 7
- 6.5
- 6.75
- 6.25

The area enclosed between the curve \( y = \log_e (x + e) \) and the coordinate axes is:

- 4
- 3
- 2
- 1
If \( \cos^{-1}\left(\frac{1}{x}\right) = \theta \), then \( \tan \theta = \frac{\sqrt{x^2 - 1}}{\sqrt{1 - x^2}} \) or \( \frac{\sqrt{x^2 + 1}}{1/\sqrt{x^2 - 1}} \).

A school committee consists of 2 teachers and 4 students. The number of different committees that can be formed from 5 teachers and 10 students is:

- 10
- 15
- 2100
- 8

The number of real roots of the equation \( e^{\sin x} - e^{-\sin x} - 4 = 0 \) are:

- 3
- 1
- Infinite
- None

The period of \( 2 \sin x \cos x \) is:

- \( 4\pi \)
- \( 4\pi^2 \)
- \( 2\pi \)
- \( \pi \)

In a single throw of two dice, the probability of getting more than 7 is:

- \( 5/36 \)
- \( 7/12 \)
- \( 7/36 \)
- \( 5/12 \)
Square of either of the two imaginary cube roots of unity will be:

- Real root of unity
- Other imaginary cube root of unity
- Sum of two imaginary roots of unity
- None of these

If in a triangle ABC, the altitudes from the vertices A, B, C on opposite sides are in H.P., then sin A, sin B, sin C are in:

- H.P.
- Arithmetic – Geometric Progression
- A.P.
- G.P.

The number of values of x in the interval [0, 3π] satisfying the equation 2sin2x + 5sinx – 3 = 0 is:

- 6
- 2
- 1
- 4

The expression \((2 + \sqrt{2})^4\) has value, lying between:

- 134 and 135
- 135 and 136
- 136 and 137
- None of these

The sum of 3 numbers in geometric progression is 38 and their product is 1728. The middle number is:

- 12
- 8
- 6
- 18
Two circles have equations \( x^2 + y^2 = 16 \) and \( (x - 2)^2 + y^2 = 4 \). Which of the following correctly describes the relative position of the two circles.

- The two circles touch externally
- The two circles touch internally
- The circles do not touch or intersect
- The two circles intersect

The degree and order of the differential equation of the family of all parabolas whose axis is x-axis, are respectively:

- 2, 1
- 1, 2
- 2, 3
- 3, 2

The ends of latus rectum of parabola \( x^2 + 8y = 0 \) are:

- \((-4, -2)\) and \((4, -2)\)
- \((4, 2)\) and \((-4, 2)\)
- \((4, -2)\) and \((-4, 2)\)
- \((-4, -2)\) and \((4, 2)\)

The points \((0, 8/3), (1, 3)\) and \((82, 30)\) are the vertices of:

- A right angled triangle
- A right angled triangle
- An equilateral triangle
- None of these

Which vector is perpendicular to the plane containing the three points \(P(2, 1, 5), Q(-1, 3, 4),\) and \(R(3, 0, 6)\)?

- \(2i + 2j - k\)
- \(2i - j + k\)
- \(i + 2j + 2k\)
- \(i + 2j + k\)
If $^{12}\text{P}_n$, then $r$ is equal to:

- 3
- 2
- 4
- 5

The condensation polymer among the following is:

- Protein
- PVC
- Polythene
- Rubber

The laws of electrolysis were proposed by:

- Fritz Haber
- Friedrich Kohlrausch
- Michael Faraday
- Richard Abegg

Which of the following electrolytic solutions has the least specific conductance?

- 0.02N
- 0.2N
- 0.002N
- 2N

What is the electrochemical equivalent (in g coulomb$^{-1}$) of silver? ($\text{Ag} = 108; \text{F} = \text{Faraday}$)

- 108 F
- 1/108 F
- F/108
- 108/F

During the process of electrolytic refining of copper, some metals present as impurity settle as 'anode mud'. These are:
86 of 100
208 PU_2015_305
Amongst the following the most basic compound is:-
- acetanilide
- p-nitroaniline
- aniline
- benzyamine

87 of 100
212 PU_2015_305
The best way to prevent rusting of iron is:-
- putting it in an acidic solution
- making iron cathode
- both (A) and (B)
- neither (A) nor (B)

88 of 100
204 PU_2015_305
The number and type of bonds between two carbon atoms in calcium carbide are:-
- One sigma, one pi
- Two sigma, one pi
- One sigma, two pi
- Two sigma, two pi

89 of 100
196 PU_2015_305
The number of d-electrons in Fe2+ (Z = 26) is not equal to that of:-
- d-electrons in Fe (Z=26)
- p-electrons in Ne (Z=10)
- s-electrons in Mg (Z=12)
- p-electrons in Cl(Z=17)

90 of 100
206 PU_2015_305
Which of the following is fully fluorinated polymer?
- PVC
- Teflon
Which one of the following pairs of species have the same bond order?
- O\(^-\) and CN\(^-\)
- CN\(^-\) and NO\(^+\)
- NO\(^-\) and CN\(^+\)
- CN\(^-\) and CN\(^+\)

The number of moles of solute present in 1 kg of a solvent is called its:
- Molarity
- Normality
- Molality
- Formality

(NH\(_4\))\(_2\)Cr\(_2\)O\(_7\) On heating gives a gas which is also given by:
- heating NH\(_4\)NO\(_2\)
- Mg\(_3\)N\(_2\) + H\(_2\)O
- Na (comp.) + H\(_2\)O\(_2\)
- heating NH\(_4\)NO\(_3\)

Which one of the following does not involve coagulation?
- Peptization
- Clotting of blood by the use of ferric chloride
- Formation of delta regions
- Treatment of drinking water by potash alum

Which of the following factors is of no significance for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly?
- Metal sulphides are less stable than the corresponding oxides
- CO\(_2\) is thermodynamically more stable than CS\(_2\)
- Metal sulphides are thermodynamically more stable than CS\(_2\)
CO₂ is more volatile than CS₂

96 of 100
254 PU_2015_305
The potential of a hydrogen electrode at pH = 10 is:-
☐ -0.59V
☐ 0.059V
☐ 0.00V
☐ 0.59V

97 of 100
292 PU_2015_305
Phenol, when it first reacts with concentrated sulphuric acid and then with concentrated nitric acid, gives:-
☐ p-nitrophenol
☐ nitrobenzene
☐ o-nitrophenol
☐ 2,4,6-trinitrobenzene

98 of 100
296 PU_2015_305
Which of the following arrangements does not represent the correct order of the property stated against it?
☐ Co³⁺< Fe³⁺< Cr³⁺< Sc³⁺ : stability in aqueous solution
☐ Sc<Ti<Cr<Mn: number of oxidation states
☐ V²⁺< C⁰⁺< Mn³⁺< Fe²⁺ : paramagnetic behavior
☐ Ni²⁺< Co⁺⁺< Fe²⁺< Mn²⁺ : ionic size

99 of 100
298 PU_2015_305
Based on the first law of thermodynamics, which one of the following is correct?
☐ For an isochoric process, ΔU = Δq
☐ For an adiabatic process, ΔU = Δw
☐ For a cyclic process, q = Δw
☐ For an isothermal process, q = +w

100 of 100
294 PU_2015_305
Reaction of one molecule of HBr with one molecule of 1,3-butadiene at 40°C gives predominantly.
☐ 3-bromobutene under kinetically controlled conditions
☐ 1-bromo-2-butene under thermodynamically controlled conditions
☐ 1-bromo-2-butene under kinetically controlled conditions
☐ 3-bromobutene under thermodynamically controlled conditions