Group I contains elementary excitations in solids. Group II gives the associated field with these excitations. MATCH the excitations with their associated field and select your answer as per codes given below.

<table>
<thead>
<tr>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P) phonon</td>
<td>(i) photon + lattice vibration</td>
</tr>
<tr>
<td>(Q) plasmon</td>
<td>(ii) electron + elastic deformation</td>
</tr>
<tr>
<td>(R) polaron</td>
<td>(iii) collective electron oscillations</td>
</tr>
<tr>
<td>(S) polariton</td>
<td>(iv) elastic wave</td>
</tr>
</tbody>
</table>

- (P - iv), (Q - iii), (R - ii), (S - i)
- (P - iv), (Q - iii), (R - i), (S - ii)
- (P - i), (Q - iii), (R - ii), (S - iv)
- (P - iii), (Q - iv), (R - ii), (S - i)

2 of 100

A live music broadcast consists of a radio-wave of frequency 7 MHz, amplitude-modulated by a microphone output consisting of signals with a maximum frequency of 10 kHz. The spectrum of modulated output will be zero outside the frequency band:

- 6.99 MHz to 7.00 MHz
- 6.995 MHz to 7.005 MHz
- 7.00 MHz to 7.01 MHz
- 6.99 MHz to 7.01 MHz

3 of 100

For an ideal Fermi gas in three dimensions, the electron velocity $V_F$ at the Fermi surface is related to electron concentration $n$ as:

- $V_F \propto n^{1/2}$
- $V_F \propto n^{1/3}$
- $V_F \propto n$
- $V_F \propto n^{2/3}$

4 of 100

A charged particle is at a distance $d$ from an infinite conducting plane maintained at zero potential. When released from rest, the particle reaches a speed $u$ at a distance $d/2$ from the plane. At what distance from the plane will the particle reach the speed $2u$:
5 of 100  
112 PU_2015_160  
The number of degrees of freedom of a rigid body in d space-dimensions is:-  
☐ 2d  
☐ d(d +1)/ 2  
☐ d!  
☐ 6

6 of 100  
110 PU_2015_160  
Two bodies of equal mass m are connected by a massless rigid rod of length l lying in the xy-plane with the centre of the rod at the origin. If this system is rotating about the z-axis with a frequency ω, its angular momentum is:-  
☐ ml²ω/ 4  
☐ ml²ω/ 2  
☐ ml²ω  
☐ 2ml²ω

7 of 100  
113 PU_2015_160  
The recently-discovered Higgs boson at the LHC experiment has a decay mode into a photon and a Z boson. If the rest masses of the Higgs and Z boson are 125 GeV/c² and 90 GeV/c² respectively, and the decaying Higgs particle is at rest, the energy of the photon will approximately be:-  
☐ 35(3)¹/² GeV  
☐ 15 GeV  
☐ 35 GeV  
☐ 30 GeV

8 of 100  
115 PU_2015_160  
A beam of light of frequency ω is reflected from a dielectric-metal interface at normal incidence. The refractive index of the dielectric medium is n and that of the metal is n₂ = n(1 + ip). If the beam is polarised parallel to the interface, then the phase change experienced by the light upon reflection is:-  
☐ \tan^{-1}(2p)  
☐ \tan^{-1}(2 /p)  
☐ \tan(2 /p)
9 of 100
121 PU_2015_160
An RC network produces a phase-shift of 30°. How many such RC networks should be cascaded together and connected to a Common Emitter amplifier so that the final circuit behaves as an oscillator?
- 13
- 9
- 6
- 12

10 of 100
108 PU_2015_160
A horizontal circular platform mutes with a constant angular velocity $\Omega$ directed vertically upwards. A person seated at the centre shoots a bullet of mass $m$ horizontally with speed $v$. The acceleration of the bullet, in the reference frame of the shooter, is:
- $v\,\Omega$ to his right
- $v\,\Omega$ to his left
- $2v\,\Omega$ to his right
- $2v\,\Omega$ to his left

11 of 100
102 PU_2015_160
Which one of the following CANNOT be explained by considering a harmonic approximation for the lattice vibrations in solids?
- Thermal expansion
- Optical branches in lattices
- DulongPetit’s law
- Deby’s $T^3$ law

12 of 100
103 PU_2015_160
The acceleration due to gravity ($g$) on the surface of Earth is approximately 2.6 times that on the surface of Mars. Given that the radius of Mars is about one half the radius of Earth, the ratio of the escape velocity on Earth to that on Mars is approximately:
- 1.1
- 1.3
- 5.2
- 2.3

13 of 100
224 PU_2015_160
Which of the following atoms cannot exhibit Bose-Einstein condensation, even in principle?

\[ \tan^{-1}\left(\frac{1}{\rho}\right) \]
A spectral line due to a transition from an electronic state \( p \) to an \( s \) state splits into three Zeeman lines in the presence of a strong magnetic field. At intermediate field strengths the number of spectral lines is:

- 6
- 3
- 9
- 10

If Planck's constant were zero, then the total energy contained in a box filled with radiation of all frequencies at temperature would be \((kT)\) (where \( k \) is the Boltzmann constant and \( T \) is nonzero):

- \( kT \)
- Infinite
- \((3/2)kT\)
- Zero

The electronic energy levels in a hydrogen atom are given by \( E_n = -13.6/\sqrt{n^2} \) eV. If a selective excitation to the \( n = 100 \) level is to be made using a laser, the maximum allowed frequency line-width of the laser is:

- 6.5 kHz
- 6.5 MHz
- 6.5 GHz
- 6.5 Hz

Two gases separated by an impermeable but movable partition are allowed to freely exchange energy. At equilibrium, the two sides will have the same:

- Volume and temperature
- Pressure and volume
- Pressure and temperature
- Volume and energy
Far away from any of the resonance frequencies of a medium, the real part of the dielectric permittivity is:
- Monotonically decreasing with frequency
- A non-monotonic function of frequency
- Monotonically increasing with frequency
- Always independent of frequency

The entropy function of a system is given by $S(E) = aE(E_0 - E)$ where $a$ and $E_0$ are positive constants. The temperature of the system is:
- decreases monotonically with energy
- negative for some energies
- increases monotonically with energy
- Zero

Consider X-ray diffraction from a crystal with a face-centered-cubic (fcc) lattice. The lattice plane for which there is NO diffraction peak is:
- $(2, 0, 0)$
- $(3, 1, 1)$
- $(1, 1, 1)$
- $(2, 1, 2)$

A culture vessel in which physical, physiochemical and physiological conditions, as well as cell concentration, are kept constant is known as:
- Biostat
- Batch bioreactor
- Incubator
- Cell concentration

Multiplication of genetically identical copies of a cultivar by asexual reproduction is known as:
- polyclonal propagation
- Vegetative propagation
Clonal propagation

clonal propagation

23 of 100
127 PU_2015_160
Si RNA(s) interfere at:-
- Post-transcriptional level
- Translational level
- Transcriptional level
- DNA replication level

24 of 100
140 PU_2015_160
Caspases are involved in the process of:-
- DNA replication
- Antibody synthesis
- Apoptosis
- Mutation and recombination

25 of 100
133 PU_2015_160
Parthenogenetic embryos in plants are those which are formed by:-
- Unfertilized eggs
- Fertilized eggs
- male gametophyte
- Sporophytic cells

26 of 100
129 PU_2015_160
A protein binds to phosphocellulose column at pH 7.0 and elutes at pH 8.0. If the protein has to be further purified on a DEAE Sephacel column, the binding buffer should have a pH of:-
- 7
- 5
- 6
- 8

27 of 100
126 PU_2015_160
Protein binding regions of DNA are identified by one of the following techniques:-
- Western blotting
28 of 100
Which one of the following techniques is best suited for immobilizing an affinity ligand?
- Cross-linking with a polymer
- Physical absorption
- Gel entrapment
- Covalent linkage to a spacer arm

29 of 100
A bioremedial solution to reduce oxides of nitrogen and carbon in flue gases is to integrate flue gas emission to:
- micro-algal culture
- Seri culture
- Fish culture
- mushroom culture

30 of 100
Program used for essentially local similarity search is:
- BLAST
- SWISS-PROT
- RasMol
- Ex PASY

31 of 100
To produce plants that are homozygous for all traits, the best choice is:
- Cell suspension culture
- Apical meristem culture
- Protoplast culture
- Anther and pollen culture

32 of 100
Antibiotic resistance marker that CANNOT be used in cloning vector in Gram negative bacteria is:
Vancomycin
- Ampicillin
- Kanamycin
- Streptomycin

33 of 100
230 PU_2015_160
A culture of bacteria is infected with bacteriophage at a multiplicity of 0.3. The probability of a single cell infected with 3 phages is:-
- 0.027
- 0.27
- 0.9
- 0.009

34 of 100
229 PU_2015_160
Which of the following DOES NOT belong to the domain of bacteria?
- Methanobacteria
- Cyanobacteria
- Bacteroids
- Proteobacteria

35 of 100
233 PU_2015_160
During lactic acid fermentation, net yield of ATP and NADH per mole of glucose is:-
- 4 ATP and 2 NADH
- 2 ATP and 2 NADH
- 2 ATP and 0 NADH
- 4 ATP and 0 NADH

36 of 100
232 PU_2015_160
Lymphocytes interact with foreign antigens in:-
- Bone marrow
- Lymph nodes
- Peripheral blood
- Thymus

37 of 100
271 PU_2015_160
What product will result from complete hydrolysis of soluble dextran?
- Fructose only
- Glucose and Fructose only
- Glucose only
- Sucrose only

38 of 100
274 PU_2015_160
Which of the following fluorescent probes is used to monitor the progress of amplification in Real time PCR?
- Rhodamine
- Cyan blue
- SYBR green
- FITC

39 of 100
272 PU_2015_160
Aeration in a bioreactor is provided by:
- charger
- impeller
- sparger
- baffles

40 of 100
269 PU_2015_160
Ultrafiltration process cannot be used for:
- harvesting of cells
- selective removal of solvents
- Fractionation of proteins
- desalting

41 of 100
162 PU_2015_160
The number of atoms in hexagonal close packed unit cell is:
- 4
- 6
- 3
- 2

42 of 100
Heat of sublimation at standard condition is high for:-
- FeO
- Mg
- Al
- TiO₂

A steel body is moving against the following materials - in which case the friction will be maximum:-
- aluminum
- copper
- wood
- steel

Which among the following has body centered cubic structure?
- copper
- sodium
- carbon
- cobalt

Hardness of a material refers to the:-
- ability to drawn into wires
- opposition to the corrosion
- opposition to the plastic deformation
- ease of malleability

Which one of the following is not a composite?
- bone
- sand
- fiberglass
- polymer
Glass fibers are examples for:-

- photonic material
- semiconductor material
- conducting material
- protonic conductor material

For a material to be used as spring, it should possess:-

- plasticity
- ductility
- hardness
- resilience

A metal body during a process forms a few nanometer thick oxide. What technique would be preferred to quantify the oxide formation and nature of oxide:-

- X-ray diffraction
- Infrared spectroscopy
- X-ray photoelectron spectroscopy
- UV-Visible spectroscopy

From the following statements pick up the TRUE one about brittle fracture:-

- Noise precedes before brittle fracture
- Generally materials with hexagonal close packed structure shows brittle fracture
- Brittle fracture is characterized by cup and cone formation
- High temperature always favour brittle fracture.

Burgers vector is related to:-

- vacancy
- dislocation
- fatigue
- creep
Artificial hip joint materials require:-
- high ultimate strength parallel to bone axis
- high friction coefficient
- high elongation perpendicular to bone axis
- low ultimate strength parallel to bone axis

Identify the statement which is NOT true among the following regarding the formation of substitutional solid solution:
- Similar electronegativity favours substitutional solid solution
- Atomic radii should be less than 15%
- For solid solubility the atoms need not have to have the same crystal structure
- The metal with higher valency dissolves in lower valency

Fracture toughness ($K_c$) is proportional to crack length ($a$) by:-
- $a$
- $a^2$
- $a^3$
- $\sqrt{a}$

Fatigue life cannot be improved by:-
- carburizing and nitriding process
- surface finishing by better polishing
- introducing tensile stress along the surface
- reducing the mean stress

Thermal conductivity of polymers and ceramics are poor due to:-
- high free electron concentration
- high electrical conductivity
- high phonon conduction
- high electron scattering
Wiedemann-Franz law is related to:

- deformation in plastics
- optical properties of thin films
- thermal conductivity of metals
- mobility of charge carriers

Hardness cannot be improved by:

- normalizing
- nitriding
- annealing
- alloying

On heating one solid phase transforming to one solid and another liquid phase is known as:

- hypoeutectic reaction
- peritectic reaction
- eutectic reaction
- hypereutectic reaction

MnO exhibits:

- paramagnetism
- ferromagnetism
- ferrimagnetism
- antiferromagnetism

If the first term minus third term of a G. P. = 768 and the third term minus seventh term of the same G. P. = 240, then the product of first 21 terms =

- 3
- 2
- 1
Laplace transform of \( \sin \) at \( s \) is:-

\[
\frac{1}{s^2 + a^2}
\]

An unbiased die with faces marked 1, 2, 3, 4, 5 and 6 is rolled four times. Out of four face values obtained, the probability that the minimum face value is not less than 2 and the maximum face value is not greater than 5 is then:-

\[
\frac{65}{81}
\]

\[
\frac{80}{81}
\]

\[
\frac{16}{81}
\]

\[
\frac{1}{81}
\]

Which of the following is the Highest Common Factor of 18, 24 and 36?

\[
72
\]

\[
6
\]

\[
36
\]

\[
18
\]

The number of real solutions of the equation \( x^2 - 3 \mid x \mid + 2 = 0 \) is:-

\[
1
\]

\[
3
\]

\[
2
\]

\[
4
\]

How many subsets does the set \( \{a, b, c, d, e\} \) have?
67 of 100
178 PU_2015_160
The period of \(|\sin (3x)|\) is:-
☐ \(2\pi\)
☐ \(3\pi\)
☐ \(2\pi/3\)
☐ \(\pi/3\)

68 of 100
175 PU_2015_160
A hollow iron pipe is 21 cm long and its external diameter is 8 cm. If the thickness of the pipe is 1 cm and iron weighs 8 g/cm\(^3\), then the weight of the pipe is:-
☐ 36.9 kg
☐ 36 kg
☐ 3.6 kg
☐ 3.696 kg

69 of 100
190 PU_2015_160
If the order of matrix A is \(m \times p\). And the order of B is \(p \times n\). Then the order of AB is ?
☐ \(m \times p\)
☐ \(m \times n\)
☐ \(n \times p\)
☐ \(n \times m\)

70 of 100
176 PU_2015_160
The population of a country increased by an average of 2% per year from 2000 to 2003. If the population of this country was 2 000 000 on December 31, 2003, then the population of this country on January 1, 2000, to the nearest thousand would have been:-
☐ 1 852 000
☐ 1 500 000
☐ 1 846 000
☐ 1 000 000
What is $a$, if $B = \begin{bmatrix} 1 & 4 \\ 2 & a \end{bmatrix}$ is a singular matrix?

- 7
- 8
- 5
- 6

The exam scores of all 500 students were recorded and it was determined that these scores were normally distributed. If Jane’s score is 0.8 standard deviation above the mean, then how many, to the nearest unit, students scored above Jane:

- 106
- 394
- 250
- 400

If $(2/3)^x + 2 = (3/2)^{2+2x}$ then $x =

- 4
- 0
- 3
- 1

How many numbers of five digits can be formed from the numbers 2, 0, 4, 3, 8 when repetition of digits is not allowed:

- 14
- 114
- 120
- 96

The equation of the straight line passing through the point (3, 2) and perpendicular to the line $y = x$ is:-
76 of 100
249 PU_2015_160
If \(2a + 3b + 6c = 0\), then at least one root of the equation \(ax^2 + bx + c = 0\) lies in the interval:-
- (2, 3)
- (0, 1)
- (1, 3)
- (1, 2)

77 of 100
284 PU_2015_160
The magnitudes of mutually perpendicular forces \(a\), \(b\) and \(c\) are 2, 10 and 11 respectively. Then the magnitude of its resultant is:-
- 9
- 15
- 12
- None

78 of 100
290 PU_2015_160
If \(a = \cos \alpha + i \sin \alpha\) and \(b = \cos \beta + i \sin \beta\), then the value of \(\frac{1}{2} \left( \frac{ab + 1}{ab} \right)\) is
- \(\sin (\alpha - \beta)\)
- \(\cos (\alpha - \beta)\)
- \(\cos (\alpha + \beta)\)
- \(\sin (\alpha + \beta)\)

79 of 100
287 PU_2015_160
If two distinct chords drawn from the point \((p, q)\) on the circle \(x^2 + y^2 = px + qy\) (where \(pq \neq 0\)) are bisected by the X-axis, then:-
- \(p^2 < 8q^2\)
- \(p^2 > 8q^2\)
- \(p^2 = 8q^2\)
\[ p^2 = q^2 \]

80 of 100
291 PU_2015_160
For all complex numbers \( z_1, z_2 \) satisfying \( |z_1| = 12 \) and \( |z_2 - 3 - 4i| = 5 \), the minimum value of \( |z_1 - z_2| \) is:
- 7
- 2
- 17
- 0

81 of 100
218 PU_2015_160
Which of the following units represents largest amount of energy?
- Calorie
- Erg
- Joule
- Electron volt

82 of 100
205 PU_2015_160
The lightest particle is:
- Neutron
- \( \alpha \)-particles
- Proton
- Positron

83 of 100
197 PU_2015_160
Halogen belongs to the:
- s-block of the periodic table
- d-block of the periodic table
- p-block of the periodic table
- f-block of the periodic table

84 of 100
206 PU_2015_160
The shape of a orbital is:
- Spherical
- Pyramidal
- Dum-bell shaped
The elements with atomic number 10, 18, 36, 54 and 86 are all:

- Rare earth metals
- Halogen
- Light metals
- Inert gases

Which is buffer solution among the following?

- CH\(_3\)COOH + CH\(_3\)COONa
- NaOH + NaCl
- CH\(_3\)COOH + CH\(_3\)COON\(_4\)
- CH\(_3\)COOH + NH\(_4\)Cl

In the following reaction the conjugate pair is:

\[ CH_3COOH + H_2O \leftrightarrow H_2O + \cdots CH_3COO^- \]

- CH\(_3\)COOH and CH\(_3\)COO\(^-\)
- H\(_2\)O and CH\(_3\)COO\(^-\)
- CH\(_3\)COO\(^-\) and H\(_3\)O\(^+\)
- CH\(_3\)COOH and H\(_3\)O\(^+\)

CH\(_3\)COOH is a weak acid because:

- It decomposes easily
- It reacts very mildly
- It is very heavy
- It ionizes slightly

The theory of ionization was given by:
Faraday
Arrhenius
Rutherford
Graham

90 of 100
209 PU_2015_160
Which of the following has more unpaired electron?
- Zn^{2+}
- Fe^{2+}
- Cu^{+}
- N^{3+}

91 of 100
213 PU_2015_160
Rate of reaction:-
- Does not depend on boiling point
- Does not depend on temperature
- Decrease with increase in temperature
- Increase with increase in temperature

92 of 100
198 PU_2015_160
Which is not a colligative property?
- Osmotic pressure
- Depression in freezing point
- Optical activity
- Elevation in boiling point

93 of 100
258 PU_2015_160
Which of the following undergoes the Grignard like reaction?
- Reformatsky reaction
- Perkin reaction
- Witting reaction
- Hydroboration

94 of 100
257 PU_2015_160
Porphyrins are:-
Tetradentate
Ambidentate
Tridentate
Bidentate

Which of the following nuclei is unstable?
- $\overset{14}{7}N$
- $\overset{16}{8}O$
- $\overset{10}{5}B$
- $\overset{10}{4}Be$

For an ideal gas Joule-Thomson coefficient is:-
- Dependent on molecular weight
- Zero
- Negative
- Positive

Which solvent is employed in hydrothermal reaction?
- Oil
- Methanol
- Ethylene glycol
- Water

How we can find the particle size of the nanoparticle?
- TGA
- XPS
- FTIR
- TEM
Ball milling is working in which technique?
☐ Electrical
☐ Optical
☐ Soft chemical
☐ Mechanical

100 of 100

How many types of electronic transition are possible in visible and UV regions?
☐ Two types
☐ Three types
☐ Four types
☐ One type