Solid State Physics and Semiconductor Physics combine question set for Test exam

Q1. A semiconductor is formed by …… bonds.

(a) Covalent

(b) Electrovalent

(c) Co-ordinate

(d) None of the above

Answer : (a) Covalent

Q2. The most commonly used semiconductor is ……..

(a) Germanium

(b) Silicon

(c) Carbon

(d) Sulphur

Answer : (b) silicon

Q3. The smallest portion of a crystal which when repeated in different directions generates the entire crystal is called:

a) Lattice points

b) Crystal lattice

c) Unit cell

d) None of the mentioned

ANS (C)

Q 4. *Electron sea* exists in
(a) Polar bonds

(b) Ionic bond

(c) Covalent bond

(d) Metallic bond

Ans (d)

Q5 Miller indices for Octahedral plane in cubic crystal
(a) (100)

(b) (110)

(c) (111)

(d) None

Ans (c)

Sample MCQ Questions SED

1) Which of the following is true?
   A. A silicon wafer heavily doped with boron is a P^+ substrate.
   B. A silicon wafer lightly doped with boron is a P^+ substrate.
   C. A silicon wafer heavily doped with arsenic is a P^+ substrate.
   D. A silicon wafer lightly doped with arsenic is a P^+ substrate.

2) Direct band gap semiconductors
   A. Exhibit short carrier life time and they are used for fabricating BJT's
   B. Exhibit long carrier life time and they are used for fabricating BJT's
   C. Exhibit short carrier life time and they are used for fabricating Lasers.
   D. Exhibit long carrier life time and they are used for fabricating BJT's

3) In a P-type Si sample the hole concentration is 2.25×10^{15} cm^{-3}. The intrinsic carrier Concentration is 1.5×10^{10} cm^{-3} the electron concentration is
   A. Zero
   B. 10^{10} cm^{-3}
   C. 10^{5} cm^{-3}
   D. 1.5×10^{25} cm^{-3}

4) If α be the current gain of a transistor in common base mode and b be the current gain in common emitter mode then,
   A. $\alpha < 1$
   B. $\beta > 1$
   C. $\alpha = \beta/(1+\beta)$
   D. All of these

5) n-channel MESFETs are superior to p-channel MESFETs because
   A. They have higher input impedance
   B. Mobility of electrons is greater than holes

C. They consume less power

D. They have higher switching time

6) The pinch off voltage for a n – channel MESFET is 4 V, when VGS = 1 V, the pinch – off occurs for VDS equal to

A. 3 V

B. 5 V

C. 4 V

D. 1 V

7) A D-MOSFET can operate in the

A. Depletion-mode only

B. Enhancement-mode only

C. Depletion-mode or enhancement-mode

D. Low-impedance

University of Mumbai
Department of Physics

Sample MCQ Question Banks for Quantum Mechanics

1. In section-I, each question carries 2 Marks.
2. In section-II, each question carries 3 Marks.

Section-I Each question carries 2 marks. Attempt 10 questions. 20

1. If ψ_1 and ψ_2 are two solutions of Schrodinger Wave equation then which of the following is also a solution?

   a $\frac{\psi_1}{\psi_2}$

   b $\psi_1\psi_2$

   c $\psi_1 - \psi_2$

   d $\psi_1 + \psi_2$

   Answer :d

2. The expectation value of which measurement cannot be calculated using the typical method?

   a Energy

   b Speed

   c Position

   d Momentum

Answer :d

3. The wave function of a particle in a box is given by

   a $\sqrt{\frac{2}{L}} \sin \frac{nx}{L}$

   b $\sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}$

   c $\sqrt{\frac{2}{L}} \sin \frac{x}{L}$

   d $\sqrt{\frac{2}{L}} \sin \frac{\pi x}{L}$

Answer :b

4. Spin Angular momentum of the particle is

   a Intrinsic property

   b Extrinsic property

   c Extrinsic and Intrinsic property

   d External property

Answer : a

5. Spherical Harmonics are the part of the

   a Orthonormal basis set

   b Orthogonal basis set

   c Orthogonal and Orthonormal basis set

   d Hilbert space

Answer : b

Section-II Each question carries three marks. Attempt 10 questions. 30

6. The WKB approximation is valid when

   a System have large mass

   b System have high energy

   c System potential varying slowly

   d System have large mass, high energy and potential slowly varying.

Answer :d

7. The ground state energy of particle in the box of side 'a'

   a $-\frac{\hbar}{2ma^2}$

   b $-\frac{\hbar^2}{ma^2}$

   c $\frac{\hbar^2}{2ma^2}$

   d $-\frac{\hbar^2}{a^2}$

Answer : c

8. The value of the commutator [Jx,Jy] is

   a $-i\hbar Jz$

   b $i\hbar Jz$

   c $-i\hbar Jx$

   d $-i\hbar Jy$

Answer : b

Subject: PSPHE 34–Biomedical Physics and Instrumentation (Elective IV)

Q.1. Electrocardiography is a medical method which makes it possible to scan and graphically record

a) electrical activity of an individual myocardial cell

b) electrical activity of the heart

c) electrical activity of a nerve fibre

d) mediated bio signal

Q.2. Sensor is

a) every device which either receives or creates a signal, mostly electric one, representing a physical phenomenon or process for further electronic processing

b) every device which creates mostly an electric signal, representing a physical phenomenon or process for further electronic processing

c) every device which receives mostly an electric signal, representing a physical phenomenon or process for further electronic processing

d) every device which electronically processes a bio signal, mostly electrical one, representing a physical phenomenon or process for further electronic processing

Q.3. Bioelectric potentials are

a) complex electric phenomena which can be detected above anatomic structures in dependence of their physiological activity and overall functional state of organism

b) simple electric phenomena which can be detected above anatomic structures in dependence of their physiological activity and overall functional state of organism

c) complex electric phenomena which cannot be detected above anatomic structures in dependence of their physiological activity and overall functional state of organism

d) complex electric phenomena which can be detected above anatomic structures and are independent from their physiological activity and overall functional state of organism

Q.4. Nuclear magnetic resonance use for activation a mediated bio signal

a) activation of atomic nuclei of the measured object by strong magnetic fields

b) activation of atoms with the help of strong electromagnetic fields

c) activation of atoms with the help of weak electromagnetic fields

d) activation of atoms with the help of light radiation

Q.5. Ultrasound spreads itself in a material environment with a speed which is

a) approximately the same as the speed of sound in the same material environment

b) lower as the speed of sound in the given environment

c) higher as the speed of sound in the given environment

d) different as the speed of sound in the given environment

Answer Key:

Q.1: (b), Q.2: (a), Q.3 :(a), Q.4: (a), Q.5 :(a)

Subject: PSPHE 33– Embedded C, ARM and Interfacing

(Elective Paper III)

Q.1. which of the following can be used for long distance communication?

a) I2C

b) Parallel port

c) SPI

d) RS232

Q.2. How many areas does the serial interface have?

a) 1

b) 3

c) 2

d) 4

Q.3. How many bit register set does RISC 1 model used?

a) 138*24

b) 138*32

c) 69*16

d) 69*32

Q.4. which of the following are header files?

a) #include

b) file

c) struct ( )

d) proc ( )

Q.5. Which of the following gives the final control to the programmer?

a) linker

b) compiler

c) locater

d) simulator

Answer Key

Q.1: (d), Q.2: (c), Q.3: (b), Q.4:(a), Q.5: (a)

Subject: PSPHE 22: Computer Networking

(Elective IV)

Q.1. _____is a protocol of the TCP/IP.

a) Session layer.
b) UDP.
c) Security.
d) Ethernet.

Q.2. In OSI protocol layering, every layer provides service to _____ layer.

a) Next higher.
b) Next one.
c) Peer.
d) None of the above

Q.3. Data communication standards are set de_____

a) Force.
b) Facto.
c) Format.
d) Practice.

Q.4. The symbol _____ indicates wired Fast Ethernet.

a) 100 Base-TX.
b) 10 Base-T4.
c) 100 Base-FX.
d) 10 Base-F

Q.5. In the Hamming code, redundancy bits are added in the _____ places for error detection.

a) 2, 4, 6, 8.
b) 1, 2, 4, 8.
c) 1, 3, 6, 9.
d) 2, 3, 5, 9.

Answer Key:

Q.1: (b), Q.2 :(a), Q.3 :(b), Q.4 :(c), Q.5: (b)

Subject: PSPHE 21: Digital Communication Systems and Python Programming language
(Elective III)

Q.1. What are the disadvantage of digital communication?
a) Needs less bandwidth
b) Is more complex
c) Needs more bandwidth & Is more complex
d) Less reliable

Q.2. Analog to digital conversion includes
a) Sampling
b) Quantization
c) Sampling & Quantization
d) Poor encryption algorithm

Q.3. In Delta modulation,
a) One bit per sample is transmitted
b) All the coded bits used for sampling are transmitted
c) The step size is not fixed
d) Quantization error is very large

Q.4. What will be the output of the following Python statement?

```
>>>"a"+"bc"
```

a) a
b) bc
c) bca
d) abc

Q.5. What will be the output of the following Python code?

```
>>>print (r"\hello")
```

a) a new line and hello
b) \nhello
c) the letter r and then hello
d) error

Answer Key:

Q.1: (c), Q.2: (c), Q.3: (a), Q.4. (d), Q.5 :(b)

Department of Physics (Autonomous)
University of Mumbai

PSPHE02 Particle Physics

Sample Multiple Choice Questions

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1. Two observed hadrons have the quantum numbers $(Q, B, S, C, \tilde{B})$ =$(2, 1, 0, 1, 0)$ and $(0, 0, 1, 0, -1)$, where Q is charge , B is Baryon Number, S is strangeness, C is charmness and $\tilde{B}$ is bottomness. The quark contents of the two particles are

   A. uus and $s\bar{b}$

   B. uuc and $s\bar{b}$

   C. uuc and $b\bar{s}$

   D. uuu and $b\bar{s}$

   Correct Answer: C

2. Which of the following statements is true for the process $p + \bar{p} \rightarrow \pi^+ + \pi^0$

   A. The process can take place through electromagnetic interactions but not through strong interaction

   B. The process is not allowed as it violates baryon number conservation

   C. The process is not allowed as it violates charge conservation

   D. The process is not allowed as it violates both charge conservation and baryon number conservation

   Correct Answer: C

3. In chiral representation the γ - matrices are given by

$$\gamma^0 = \begin{bmatrix} 0 & I \\ I & 0 \end{bmatrix}, \gamma^i = \begin{bmatrix} 0 & \sigma^i \\ -\sigma^i & 0 \end{bmatrix}$$

   The momentum space Dirac wave function for a particle at rest, in chiral representation, is given by

   A. $u(m, 0) = \sqrt{m} \begin{pmatrix} \xi \\ -\xi \end{pmatrix}$

B. $u(m,0) = \sqrt{m} \begin{pmatrix} \xi \\ \xi \end{pmatrix}$

C. $u(m,0) = \sqrt{m} \begin{pmatrix} \xi \\ 0 \end{pmatrix}$

D. $u(m,0) = \sqrt{m} \begin{pmatrix} 0 \\ \xi \end{pmatrix}$

where ξ is a two component spinor

Correct Answer: <u>B</u>

4. Quark Model wave function for Ω in spin $|\frac{3}{2}, \frac{1}{2}\rangle$ state is given by

   A. $s(\uparrow)s(\uparrow)s(\uparrow)$

   B. $s(\uparrow)s(\uparrow)s(\downarrow)$

   C. $\frac{1}{3}[s(\uparrow)s(\uparrow)s(\downarrow) + s(\uparrow)s(\downarrow)s(\uparrow) + s(\downarrow)s(\uparrow)s(\uparrow)]$

   D. $\frac{1}{3}[s(\uparrow)s(\downarrow)s(\downarrow) + s(\downarrow)s(\downarrow)s(\uparrow) + s(\uparrow)s(\downarrow)\uparrow)]$

   Correct Answer: <u>C</u>

5. Spin averaged amplitude for electron muon scattering $e^-(p_1) + \mu^-(p_2) \rightarrow e^-(p_1') + \mu^-(p_2')$ is given by

$$\langle|\mathcal{M}|^2\rangle = \frac{e^4}{4q^4} Tr\Big[\gamma^\mu(\not{p}_1 + m)\gamma^\nu(\not{p}_1' + m)\Big]$$

$$\times Tr\Big[\gamma_\mu(\not{p}_2 + M)\gamma_\nu(\not{p}_2' + M)\Big]$$

   The value of the first trace in this expression is

   A. $4(p_1^\mu p_1'^\nu - g^{\mu\nu} p_1.p_1' + p_1'^\mu p_1^\nu + m^2 g^{\mu\nu})$

   B. $4(p_1^\mu p_1'^\nu + g^{\mu\nu} p_1.p_1' + p_1'^\mu p_1^\nu + m^2 g^{\mu\nu})$

   C. $4(p_1^\mu p_1'^\nu + p_1'^\mu p_1^\nu)$

   D. $4(p_1^\mu p_1'^\nu - g^{\mu\nu} p_1.p_1' + p_1'^\mu p_1^\nu) + m^2 g^{\mu\nu}$

   Correct Answer: <u>A</u>

Advanced Electronics
PSPHC04

MCQ for practice

1. 8051 series has how many 16 bit registers?
a) 2
b) 3
c) 1
d) 4

2. What is the time taken by one machine cycle if crystal frequency is 2MHz?
a) 1.50 micro seconds
b) 0.50 micro seconds
c) 0.75 micro seconds
d) 1.00 micro seconds

3. Which architecture provides separate buses for program and data memory?
a) Harvard architecture
b) Von Neumann architecture
c) digital architecture
d) Analog arcitecture

4. RISC stands for _____
a) Restricted Instruction Sequencing Computer
b) Restricted Instruction Sequential Compiler
c) Reduced Instruction Set Computer
d) Reduced Induction Set Computer

5. Output of A/D converter is _____
a) given to an analog display
b) given to a voltmeter
c) given to a CRO
d) given to a digital display

Solution
1. a, 2. b 3. a, 4. c 5. d

Department of Physics (Autonomous)
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PSPHC13 - Numerical Techniques and Programming

Sample Multiple Choice Questions

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1. Consider a system of linear equations with N unknowns, $Ax = b$, where A is the matrix of the coefficients and b is the column matrix of constants. If A matrix is an upper triangular matrix, then formula for calculating the values of unknown x_i's is given by

   A. $x_i = \left(b_i - \sum_{j=i+1}^{N} a_{ij}x_j\right)/a_{ii}$

   B. $x_i = \left(b_i - \sum_{j=1}^{N-1} a_{ij}x_j\right)/a_{ii}$

   C. $x_i = \left(b_i - \sum_{j=1}^{i-1} a_{ij}x_j\right)/a_{ii}$

   D. $x_i = \left(b_i - \sum_{j=1}^{N} a_{ij}x_j\right)/a_{ii}$

   where a_{ij} is the $(ij)^{th}$ element of the A matrix.

   Correct Answer: <u>A</u>

2. The rectangle rule for an integration is given by $\int_a^b f(x)dx = (b-a)f(a)$. The error in its estimation is given by

   A. $\frac{f'(\eta)}{24}(b-a)^2$

   B. $\frac{f'(\eta)}{2}(b-a)^2$

   C. $\frac{f''(\eta)}{24}(b-a)^3$

   D. $\frac{f''(\eta)}{2}(b-a)^3$

   where $a < \eta < b$.

   Correct Answer: <u>B</u>

3. The minimum number of iterations required for converging to a root in the interval of [0,1] for a accuracy of 10^{-3} by bisection method is

   A. 4

   B. 7

   C. 10

D. 14

Correct Answer: C

4. Which of the following represents the mid-point formula for solving first order ordinary differential equation?

   A. $u_{j+1} = u_{j-1} + 2hf_j$

   B. $u_{j+1} = u_{j-1} + 2hf_{j-1}$

   C. $u_{j+1} = u_j + 2hf_j$

   D. $u_{j+1} = u_j + 2hf_{j-1}$

   where $j = 0, 1, 2, \cdots, N-1$

   Correct Answer: A

5. In the Newton-Raphson method for carrying out optimization of a function of one variable $f(x)$, the value of x after $(k+1)^{th}$ iteration is given by

   A. $x^{k+1} = x^k + \frac{f(x^k)}{f'(x^k)}$

   B. $x^{k+1} = x^k - \frac{f(x^k)}{f'(x^k)}$

   C. $x^{k+1} = x^k + \frac{f'(x^k)}{f''(x^k)}$

   D. $x^{k+1} = x^k - \frac{f'(x^k)}{f''(x^k)}$

   where $f'(x^k)$ and $f''(x^k)$ are the first and second derivatives of $f(x)$ at $x = x^k$.

   Correct Answer: D

PSPHE16 Nanoscience and Nanotechnology
Sample MCQ type

1. Nanomaterials are the materials with at least one dimension measuring less than _____
a) 1 nm
b) 500 nm
c) 100 nm
d) 1000 nm

2. The melting point of particles in nano form _____
a) Increases
b) Decreases
c) do not change
d) Increases then decreases

3. Carbon atoms make ____ type of bond with other carbon atoms.
a covalent
b ionic
c metallic
d polar

4. The size of a quantum dot is ____ nm.
a 5
b 10
c 50
d 100

5. Which of the following uses radio frequency to produce nano-films?
a) Electro chemical deposition
b) Chemical vapour deposition
c) Sol-gel technique
d) Plasma deposition

Answer
1. c,. 2. b,. 3. a,. 4. a,. 5. d

FINAL EXAMINATION SEM-IV 2019-2020 ELECTIVE – PSPHE17, ENERGY STUDIES								
Question	**Answer1**	**Answer2**	**Answer3**	**Answer4**	**CorrectOption**	**Difficulty Level**	**Marks**	**Unit**
Which of this storage device is used to store energy in form of potential energy of water	Flywheel	Wave device	Tidal basin	Pump Storage	Answer 4	Easy	2	Unit 4
Estimate the power output of a dam with h=100 m and volume flow rate Q = 10 m^3s^{-1}. (Assume efficiency is unity, ρ =10^3 kg m^{-3}, g = 9.81 m s^{-2}).	10 MW	125 mW	8.5 MW	12.5 MW	Answer 1	Easy	2	Unit 2
The power output of an impulse turbine is maximum when_____. Where u_c = Cup velocity and u = jet velocity.	u_c= 2 u	u_c= u	u_c= 0.5 u	u_c= 0.75 u	Answer 3	Medium	2	Unit 1
A sandstone aquifer at 70 ^oC is 20 m thick and 100 m wide. The density, specific heat, porosity and permeability are 2.3 x10^3 kg/m^3, 1000 J/kg^oC, 0.02, and 2 x 10^{-9} m^3/kg, respectively. Estimate the volume flow rate needed to generate a power output of 1 MW. (Assume the water inlet is at 10 ^oC, ρ_w = 10^3 kg/m^3, and c_w = 4000J/kg^oC).	2 x 10^{-5} m^3/s,	4 x 10^{-5} m^3/s,	2 x 10^{-3} m^3/s,	4 x 10^{-3} m^3/s,	Answer 3	Difficult	3	Unit 1
Compare the magnitude of the effect of sun on the tides when the sun and moon are both on the same side of the earth. (m_{sun} = 2 x 10^{30} kg, m_{moon} = 7.4 x 10^{22} kg, d_{sun} = 1.5 x 10^{11} m, d_{moon} = 3.8 x 10^8 m)	Tide level will increase by 50 %	Tide level will increase by 44%	Tide level will increase by 100%	Tide level will increase by 33%	Answer 2	Difficult	3	Unit 2

Sample Questions for Nuclear Reactions elective course

(1) One mode of decay of ^{252}Cf is spontaneous alpha emission and ^{256}Fm undergo spontaneous fission. The Q-value in each of the reaction is

(a) Q=0 and Q=positive
(b) Q=positive and Q=positive
(c) Q=positive and Q=negative
(d) Q=negative and Q=0

(2) The quantity not conserved in nuclear reactions is

(a) Isospin
(b) Parity
(c) Proton number
(d) Magnetic moment

(3) The Rutherford scattering cross section is dependent on

(a) Z^2, T_a^{-2}, and $\sin^4 (\theta /2)$
(b) Z^3, T_a^{-2}, and $\sin^4 (\theta /2)$
(c) Z^2, T_a^{-2}, and $\sin^2 (\theta /2)$
(d) Z^2, T_a^{-3}, and $\sin^4 (\theta /2)$

(4) The nuclear reaction which results from the incidence of sufficiently energetic α-particles on nitrogen nuclei is ^{14}N(^{4}He, X)n. What is the mass number of *X*?

(a) 16
(b) 18
(c) 17
(d) 20

(5) The time scale of the compound nuclear reaction is

(a) $10^{-15} - 10^{-17}$ s
(b) $10^{-2} - 10^{-4}$ s
(c) $10^{5} - 10^{7}$ s
(d) $10^{-27} - 10^{-30}$ s

Correct answers

(1) (b) Q=positive and Q=positive
(2) (d) Magnetic moment
(3) (a) Z^2, T_a^{-2}, and $\sin^4 (\theta /2)$
(4) (c) 17
(5) (a) $10^{-15} - 10^{-17}$ s

UNIVERSITY OF MUMBIA
DEPARTMENT OF PHYISCS (AUTONOMUS)
End-Semester Exam Question Paper (sample)
PSPHE 12: Materials and their Applications
Date: 16th October, 2020
Maximum Marks: 50 **Time Duration: 1hr.**

Q.1 **The wall of a steel tank containing water is corroding at a rate of 59.7 mdd, How long will it take for the wall thickness to decrease by 0.50 mm?** **(3)**

(a) 785 days

(b) 369 days

(c) 890 days

(d) 569 days

Q.2 **What is C2xxxx means** **(3)**

(a) Coppers and high copper alloys

(b) Copper-Zinc alloys

(c) Copper-zinc-tin alloys

(d) Copper zinc –lead alloys

Q.3 **Steel contains** **(2)**

(a) 80 % or more iron

(b) Alloying elements like chromium, tungsten nickel and copper

(c) 50 % or more iron

(d) Elements like phosphorus, Sulphur and silicon in varying quantities

Q.4 **Manganese (Mn) is added in low carbon steel too** **(2)**

(a) Make the steel tougher and harder

(b) Raise the yield point

(c) Make the steel ductile and of good bending qualities

(d) All of the above

Q.5 **At temperature below the glass transition temperature for thermoplastics, the creep rate is_____** **(2)**

(a) Low

(b) High

(c) Moderate

(d) None of the above

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DEPARTMENT OF PHYISCS (AUTONOMUS)
End-Semester Exam Model Question Paper
PSPHE 12: Liquid crystal

Date: 16th October, 2020
Maximum Marks: 12 **Time Duration: .**

Q.1 **Smectic is a type of liquid crystal which is based on** **(3)**

(a) Surface area

(b) Surface tension

(c) Viscosity

(d) Ordering of molecules

Q.2 **Cholestryl benzoate in milky liquid at** **(3)**

(a) 100^0C

(b) 145^0C

(c) 185^0C

(d) 285^0C

Q.3 **Liquid Crystals phase is also called** **(2)**

(a) Mesophase

(b) Hydrophane

(c) Gyrophase

(d) None of these

Q.4 **In optical polarizing microscope, if the polarized light incident on any material has its polarization direction either parallel or perpendicular to the director, it will appear ……..under crossed polarizers.** **(2)**

(a) Red

(b) Silver

(c) Grey

(d) Black

Q.5 **Thermal transitions of polymer can be determined by this technique.** **(2)**

(a) LDC

(b) DSC

(c) PDC

(d) LSC

UNIVERSITY OF MUMBAI
DEPARTMENT OF PHYISCS (AUTONOMUS)
End-Semester Exam Model Question Paper
Experimental Physics

Q.1		**Which of the following microscopy techniques depends on the specimen interfering with the wavelength of light to produce a high contrast image without any damage to the sample?**	**(3)**
	(a)	Conventional bright field light microscopy	
	(b)	Phase contrast microscopy	
	(c)	Electron microscopy	
	(d)	Fluorescence microscopy	
Q.2		**Electron Microscope can give a magnification up to_____**	**(2)**
	(a)	100,000X	
	(b)	100X	
	(c)	400,000X	
	(d)	20000X	
Q.3		**To measure the band gap of semiconductor material which of the following spectroscopy can be used**	**(2)**
	(a)	X-Ray Diffraction	
	(b)	UV-Vis Spectroscopy	
	(c)	FITR Spectroscopy	
	(d)	Raman Spectroscopy	
Q.4		**On which principle does Ionization Gauge works?**	**(2)**
	(a)	Thermal conductivity	
	(b)	Pressure difference	
	(c)	Thermionic emission	
	(d)	Electrical conductivity	
Q.5		**The best estimate of the radius of a metal sphere is 2.10mm with a standard uncertainty of 0.15mm. Determine the best estimate of volume of the sphere and the standard uncertainty in the volume. Write the standard uncertainty to two significant figures.**	**(3)**
	(a)	$38.81 \pm 8.31\ mm^3$	
	(b)	$30.23 \pm 0.33\ mm^3$	
	(c)	$52.37 \pm 9.98\ mm^3$	
	(d)	$64.8 \pm 1.32\ mm^3$	

UNIVERSITY OF MUMBAI
DEPARTMENT OF PHYSICS (AUTONOMOUS)
PSPHC05: Electrodynamics
End-Semester Exam
Date: September- October 2020 - Final weightage:

1. Example questions

1. In Electromagnetic fields, which quantity remain invariant under Lorentz transformation

   (a) $\vec{E} \times \vec{B}$ **(b)** $\vec{E}^2$ **(c)** $\vec{E}^2 - \vec{B}^2$ **(d)** $\vec{E} + \vec{B}$

2. The skin depth in poor conductors is (here, σ is conductivity, μ is permeability, ϵ is the permittivity of the medium.)

   (a) $\frac{\mu}{\sigma}\sqrt{\frac{\epsilon}{2}}$ **(b)** $\frac{\sigma}{2}\sqrt{\mu\epsilon}$ **(c)** $\frac{\sigma}{2}\sqrt{\frac{\epsilon}{\mu}}$ **(d)** $\frac{2}{\sigma}\sqrt{\frac{\epsilon}{\mu}}$

3. The gyroradius for a 10 keV electron in the Earth's magnetic field of 5×10^{-5} T is (Given; mass of electron is 9.11×10^{-31} kg, charge of electron is 1.6×10^{-19} C)

   (a) 6.75 m **(b)** 67.5 m **(c)** 675 m **(d)** 25 m

4. The homogeneous Maxwell's equation is

   (a) $\partial_\mu F^{\mu\nu} = \frac{4\pi}{c} J^\nu$ **(b)** $\partial_\mu G^{\mu\nu} = 0$ **(c)** $\partial_\mu G^{\mu\nu} = \frac{4\pi}{c} J^\nu$

   (d) $\nabla \times \vec{B} = \frac{4\pi}{c} J^\nu + \frac{1}{c}\frac{\partial \vec{E}}{\partial t}$

5. The Larmor formula for power generated by a non-relativistic accelerated charge is proportional to (here, a is an acceleration of charged particle)

   (a) a^2 **(b)** a **(c)** a^3 **(d)** a^{-2}

Department of Physics (Autonomous)
University of Mumbai

PSPHE23 - Computational Physics Methods

Sample Multiple Choice Questions

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1. Consider the evaluation of the configurational integral $Z_{NVT} = \int d\mathbf{r} \exp(-\beta E)$ for a system with $N = 300$ particles in a cube of side L If a crude Simpson's rule of integration requiring 10 function evaluations for each of the 300 coordinates, then how many total function evaluations would be required?

   A. 10^3

   B. 10^{30}

   C. 10^{300}

   D. 10^{3000}

   Correct Answer: C

2. Molecular dynamics cannot be used for which of the following process or properties?

   A. Optical excitations

   B. Breaking of solids into two or more pieces under mechanical action.

   C. Surface reconstruction

   D. Phase transitions

   Correct Answer: A

3. Which quantity is essential for simulating a system using molecular dynamics?

   A. Pressure

   B. Temperature

   C. Potential Energy

   D. Kinetic Energy

   Correct Answer: C

4. For a system of spins on a square lattice of length N the Hamiltonian is given by

$$\hat{H} = -\sum_{i=1}^{N}\sum_{j=1}^{j<i} J_{ij} S_i S_j - \mu_B H \sum_{i=1}^{N} S_i.$$

In this equation J_{ij} is

A. External field strength

B. Coupling parameter between the adjacent sites

C. Spin at the $(i,j)^{th}$ site

D. Magnetic moment at the $(i,j)^{th}$ site

Correct Answer: <u>B</u>

5. Which of the following expression represents the linear congruential random number generator.

A. $s_{i+1} = (a * s_{i-1} + b * s_{i-2} + c * s_{i-3}) \bmod m$

B. $s_{i+1} = (a * s_i + c) \bmod m$

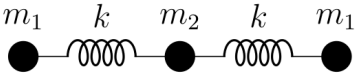
C. $s_{i+1} = (a * s_{i-1} - b * s_{i-2} + c * s_{i-3} - d * s_{i-4}) \bmod m$

D. $s_{i+1} = (s_{i-p} \pm s_{i-q}) \bmod m$

Correct Answer: <u>B</u>

UNIVERSITY OF MUMBAI
DEPARTMENT OF PHYSICS (AUTONOMOUS)
PSPHC02: Classical Mechanics
Sample Question Bank for End-Semester Exam Sep/Oct 2020

1. Consider a 3-mass and spring system constrained to move along the horizontal axis, as shown in the figure:



The number of zero-frequency normal modes for this system would be:

(a) **0**
(b) 1
(c) 2
(d) 3

Solution: (b) 1

Justification:

The translational mode where both springs remain uncompressed and all three masses move in the same direction. In this mode there is no oscillation.

2. Consider the following Lagrangian as a proposed Lagrangian for describing the motion of a charged particle of charge q and mass m in an electromagnetic field described by a scalar potential ϕ and a vector potential $\vec{A}$:

$$L = \frac{1}{2}mv^2 - q\phi + \frac{q}{c}\vec{A}\cdot\vec{v}$$

For the Lagrangian to correctly describe the system, which of the following statements is correct?

(a) **The Lagrangian is already correct.**
(b) The sign on the 2nd term must be +ve.
(c) The sign on the 3rd term must be −ve.
(d) The Lagrangian would not work without additional gauge terms.

Solution: (a) The Lagrangian is already correct.

Justification:

It has to be verified by explicit calculation.

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}}\right) = \frac{d}{dt}\left(m\dot{x} + \frac{q}{c}A_x\right) = m\ddot{x} + \frac{q}{c}\frac{dA_x}{dt}$$

$$\frac{\partial L}{\partial x} = -q\frac{\partial \phi}{\partial x} + \frac{q}{c}\frac{\partial \vec{A}}{\partial x}\cdot\vec{v}$$

$$m\ddot{x} = q\left(-\vec{\nabla}\phi - \frac{1}{c}\frac{\partial \vec{A}}{\partial t}\right)_x + \text{other terms ...}$$

This verifies the sign on term no. 2 and 3 of the Lagrangian and eliminates all the wrong options. Note that there is no need to solve till the end.

3. Consider the infinitesimal rotation matrix

$$M = \begin{bmatrix} 0 & -d\Omega & 0 \\ +d\Omega & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

This matrix would generate an infinitesimal rotation about the

(a) x-axis

(b) y-axis

(c) **z-axis**

(d) xy-plane

Solution: (c) z-axis

Justification:

It is obvious from inspection, since the matrix mixes the x- and y- entries of the vector it would act on. The only tenable option is (c).

4. Consider a one-dimensional system for which the dynamical variables are transformed as follows:

$$Q = p + iaq \qquad\qquad P = \frac{p - iaq}{2ia}$$

Given that q, p are canonically conjugate variables, the transformation to Q, P is canonical under the condition

(a) $a = 0$

(b) $a = 1$

(c) $a = -i$

(d) **for any value of a**

Solution: (d) for any value of a

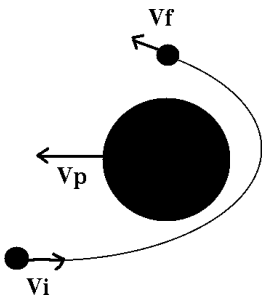
Justification:

Trivially from the fundamental Poisson bracket relation:

$$[Q, P] = \frac{1}{2ia}\left(-ia[p, q]\right) + \frac{ia}{2ia}[q, p] = 1$$

The result is independent of a, establishing the solution.

5. A representative figure for a gravity assist (or 'slingshot' manoeuvre) for a satellite scattering around a planet is shown below:



For the scenario shown, the initial and final velocities, v_i and v_f respectively, would be related as:

(a) $\mathbf{v_f > v_i}$

(b) $v_f = v_i$

(c) $v_f < v_i$

(d) insufficient data to draw any conclusion

Solution: (a) $v_f > v_i$

Justification:

In the rest frame of the planet, the velocities would be equal, say to some value v_0. Hence, in the given scenario, v_f would get boosted and v_i would be diminished. This leads to the result, essentially by mere inspection.

6. Consider a simple pendulum with a flexible string instead of a rigid one. The system is confined to a single plane. With r defined as the length of the pendulum and θ defined as the angle with respect to the negative vertical axis, a suitable Lagrangian for such a system would be:

(a) $\mathbf{\frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 + mgr}\cos\theta$

(b) $\frac{1}{2}m\dot{r}^2 - \frac{1}{2}mr^2\dot{\theta}^2 + mgr\cos\theta$

(c) $\frac{1}{2}mr^2\dot{\theta}^2 + mgr\cos\theta$

(d) $\frac{1}{2}m\dot{r}^2 + mgr\cos\theta$

Solution: (a) $\frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 + mgr\cos\theta$

Justification:

The other options are eliminated because of having incorrect / incomplete KE terms.

1.Consider following statements with respect to Born-Oppenheimer approximation:
I. It is very reliable for ground state electronic states
II.It is less reliable for excited state.
Which of the following is holds:
A. Both I and II are true
B. Both I and II are false
C. Only II is true and I is false
D. Only I is true and II is false
(2M)

2. Which of the following statements regarding electronic wavefunctions for atoms is valid:
As we move away from the center of an atom, the electronic charge density :
A. Follows a Gaussian behavior
B. Follows an exponential decrease
C. Oscillates with slowly decreasing behavior. But has exponential behavior asymptotically.
D. None of these
(2M)

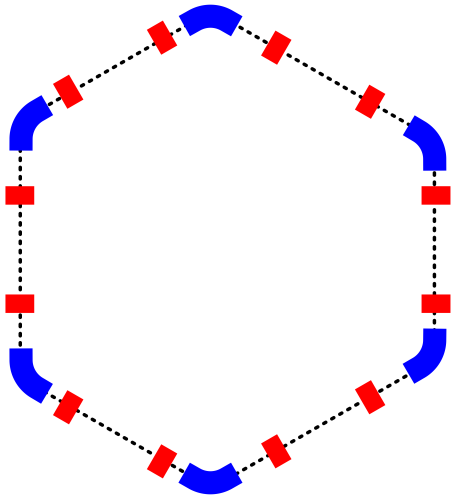
3. If we consider the Hamiltonian for a Helium atom with no electron-electron repulsion term, the total ground state energy is…
(Hint:We are considering two electrons moving independently and but feeling Coulombic interaction with nucleus.)
A. -108 eV
B. -54 eV
C.-13.6 eV
D. -26.2 eV
(3M)

4. In the weak-field Zeeman Effect regime, for the hydrogenic atom, the splitting of $1S_{1/2}$, $2P_{1/2}$ and $2P_{3/2}$ levels give rise to successively …, …. and ….levels respectively
A. 1,2,2
B. 2,2,4
C.1,2,3
D.1,3,3
(3M)

5. The number of term symbols that can arise from $2p^5$ configuration is
(Hint: You don't have to do a lengthy calculation for this. You can use the hole in a shell concept to simplify the calculation)
A. 1
B. 2
C. 3
D. 4
(2M)

UNIVERSITY OF MUMBAI
DEPARTMENT OF PHYSICS (AUTONOMOUS)
PSPHE05: Accelerator and Beam Physics
Sample Question Bank for End-Semester Exam Sep/Oct 2020

1. A highly simplified schematic layout of the IUCF Cooler accelerator and storage ring in Bloomington, USA is shown below.



Dipole magnets are shown in blue, magnetic quadrupoles are shown in red, and the beam line itself is shown as a black dotted line. The horizontal and vertical betatron tune for the storage ring are given to you as follows: $Q_h = 3.86$, $Q_v = 4.86$. Suppose one complete FODO cell is added to the storage ring by extending two opposite straight sections by one-half FODO cell each. The new values of the horizontal and vertical tunes respectively would be:

   (a) 3.86, 4.86
   (b) 3.22, 4.05
   (c) **4.50, 5.67**
   (d) 5.15, 6.48

2. The betatron envelope represents

   (a) the actual trajectory followed by the highest energy particles
   (b) the average trajectory followed by all the particles
   (c) **a cumulative outer bound on all the particle trajectories**
   (d) a profile of the magnetic field distribution

3. An electron beam ion source (EBIS) works on the following physical principle:

   (a) **radial and axial confinement and repeated ionisation by a high energy electron beam**
   (b) microwave heating of plasma electrons
   (c) Laser-driven sputtering assisted by an electron beam
   (d) a crossed beam geometry of intersecting ion and electron beams

4. In the ESR storage ring at GSI Darmstadt in Germany, He-like U ions (radius = 0.00577 Å) are injected into the ring and accelerated to 250 MeV/u. For the ion beam to be stored (without further acceleration) for a period of 3 hours, what should be the level of vacuum in the ring (in torr)? Take the temperature to be 300 K.

   [GIVEN: Mean free path λ [m] = $(1.04 \times 10^{-7} \times T$ [K]$)/(P$ [torr] $\times \sigma$ [nm^2]$)$]

   (a) 1.5×10^{-7}

   (b) 1.5×10^{-9}

   (c) $\mathbf{1.5 \times 10^{-11}}$

   (d) 1.5×10^{-13}

5. The Brookhaven Alternating Gradient Synchrotron (AGS) was designed to accelerate protons to a kinetic energy of 28.1 GeV. Au^{14+} ions (with A = 197) are injected into AGS at a kinetic energy 72 MeV/u. What is the maximum kinetic energy per nucleon for these gold ions that can be achieved in the AGS (in GeV/u)?

   (a) **1.33**

   (b) 2.26

   (c) 2.06

   (d) 2.66

6. The SPEAR colliding beam storage ring had been constructed originally for electron and positron beams to collide head-on with an energy of up to 3.5 GeV. At 1.55 GeV per beam a new particle, the J/ψ particle, was created. Determine the positron energy (in TeV) needed to create such J/ψ particles by collisions with electrons in a fixed target.

   (a) **9.4**

   (b) 88.5

   (c) 14.0

   (d) 4.7

PSPHC09

STATISTICAL MECHANICS

Sample MCQs on Units taught until 13th March 2020

Instructor: Dr Radha Srinivasan University Dept of Physics

{Difficulty level (DL) I (easy) II (medium) III (challenging)
(These are closely related to the various classification schemes of Education Technology like Bloom's Taxonomy, Student Centric Learning etc.)}

Unit I

D.L.

1. Which one of the following statements is not an elementary property of Probability? I
(S is a finite sample space and A, B are events in S.)

(a) $0 \leq P(A) \leq 1$

(b) $P(A \cup B) = P(A) + P(B)$

(c) $P(\bar{A}) = 1 - P(A)$

(d) $P(S) = 1$

2. Read the following statements A, B, C. Select from the alternatives the correct one for a Reversible Process. II

A. Possible to reverse its direction by infinitesimal change in the applied conditions

B. It must be a quasistatic process

C. There must be no hysteresis effects

(a) Only A is correct

(b) Only B is correct

(c) Only C is correct

(d) All A, B, C are correct

... 2

D.L.
III

3. If the internal energy per particle in an ideal gas is $\frac{3}{2}k_BT$ is equated to the average kinetic energy of an atom, the average velocity is $v = \sqrt{\frac{3k_BT}{m}}$,

where symbols have usual meaning.

Given $k_BT \simeq 1/40$ eV at $T = 300$ K and $m_ec^2 \simeq 0.5$ MeV where m_e is mass of electron and c is velocity of light (3×10^{10} cm/s), the estimate for average velocity for H_2 gas is

(a) $v \simeq 10^{10}$ cm/s

(b) $v \simeq 10^{8}$ cm/s

(c) $v \simeq 10^{5}$ cm/s

(d) $v \simeq 10^{-5}$ cm/s

Solutions

1 (b)

2 (d)

3 (c)

Unit II

D.L. I

1. Which set of equations ~~are~~ is correct form of the Hamiltonian equations of motion? (H, p_i, r_i and other derivatives have their usual meaning)

(a) $p_i = \frac{\partial H}{\partial r_i}$ $\quad r_i = -\frac{\partial H}{\partial p_i}$

(b) $\dot{p}_i = \frac{\partial H}{\partial p_i}$ $\quad \dot{r}_i = \frac{\partial H}{\partial r_i}$

(c) $\dot{p}_i = \frac{\partial H}{\partial r_i}$ $\quad \dot{r}_i = -\frac{\partial H}{\partial p_i}$

(d) $\dot{p}_i = \frac{\partial H}{\partial r_i}$ $\quad \dot{r}_i = \frac{\partial H}{\partial p_i}$

2. The Hamiltonian for a classical ideal gas is $H = \sum_{i=1}^{N} \frac{p_i^2}{2m}$ If $\lambda = \sqrt{\frac{2\pi\hbar^2}{m k_B T}}$ is the thermal wavelength, the expression for partition function is II

(a) $Q_N = \frac{1}{N!}\left(\frac{V}{\lambda^3}\right)^N$

(b) $Q_N = \frac{V}{3N}\left(\frac{1}{\lambda^3}\right)$

(c) $Q_N = \frac{\lambda^{3N}}{VN!}$

(d) $Q_N = \left(\frac{V}{\lambda^3}\right)^N$

D.L.

III

3. In the occupation number formalism, if n_j particles occupy g_i states having ϵ_i as the single particle energy, which of the following expressions represent the Bose distribution (α, β : Lagrange multipliers)

(a) $n_j = \dfrac{g_j}{e^{-\alpha+\beta\epsilon_j} - 1}$

(b) $n_j = \dfrac{g_j}{e^{-\alpha+\beta\epsilon_j} + 1}$

(c) $n_j = \dfrac{g_j}{e^{\alpha-\beta\epsilon_j} + 1}$

(d) $n_j = \dfrac{g_j}{e^{\alpha+\beta\epsilon_j} - 1}$

Sol.

1 (c)

2 (a)

3 (a)