

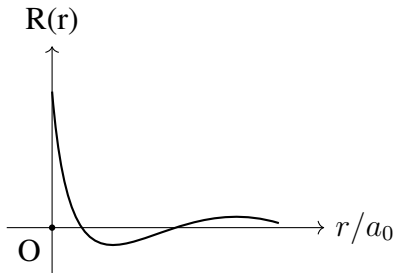
# 2018-PH-'1-13'

AI24BTECH11006 - Bugada Roopansha

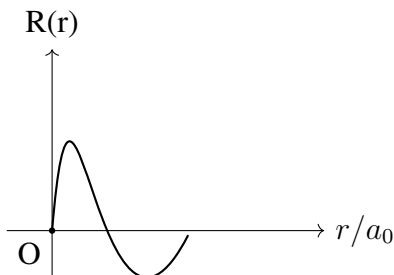
1) The eigenvalues of a Hermitian matrix are all

- a) real
- b) imaginary
- c) of modulus one
- d) real and positive

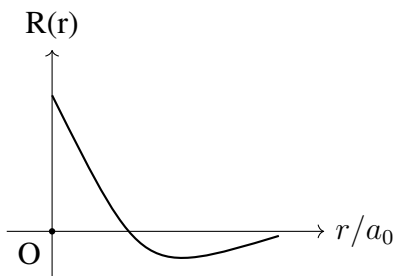
2) Which one of the following represents the  $3p$  radial wave function of the hydrogen atom? ( $a_0$  is the Bohr radius)



a)

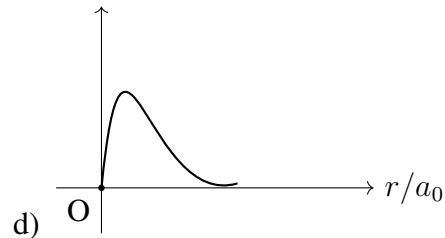


b)



c)

$R(r)$



3) Given the following table,

Group I	Group II
P: Stern-Gerlach experiment	1: Wave nature of particles
Q: Zeeman effect	2: Quantization of energy of electrons in the atoms
R: Frank-Hertz experiment	3: Existence of electron spin
S: Davisson-Germer experiment	4: Space quantization of angular momentum

Which one of the following correctly matches the experiments from Group I to their inferences in Group II?

- a) P-2, Q-3, R-4, S-1
- b) P-1, Q-3, R-2, S-4
- c) P-3, Q-4, R-2, S-1
- d) P-2, Q-1, R-4, S-3

4) In spherical polar coordinates  $(r, \theta, \phi)$ , the unit vector  $\hat{\theta}$  at  $(10, \frac{\pi}{4}, \frac{\pi}{2})$  is

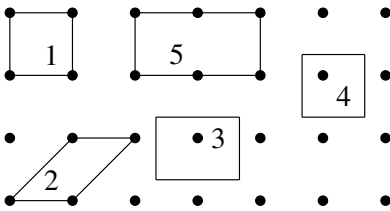
- a)  $\hat{k}$
- b)  $\frac{1}{\sqrt{2}} (\hat{j} + \hat{k})$
- c)  $\frac{1}{\sqrt{2}} (-\hat{j} + \hat{k})$
- d)  $\frac{1}{\sqrt{2}} (\hat{j} - \hat{k})$

5) The scale factors corresponding to the covariant metric tensor  $g$  in spherical polar coordinates are

- a)  $1, r^2, r^2 \sin^2 \theta$
- b)  $1, r^2, \sin^2 \theta$
- c)  $1, 1, 1$
- d)  $1, r, r \sin \theta$

6) In the context of small oscillations, which one of the following does NOT apply to the normal coordinates?

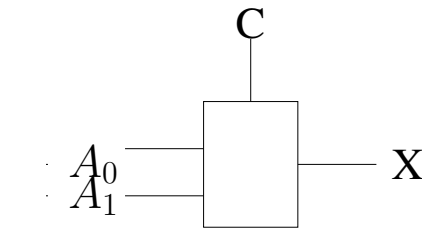
- a) Each normal coordinate has an eigen-frequency associated with it  
 b) The normal coordinates are orthogonal to one another  
 c) The normal coordinates are all independent  
 d) The potential energy of the system is a sum of squares of the normal coordinates with constant coefficients
- 7) For the given unit cells of a two-dimensional square lattice, which option lists all the primitive cells?



- a) 1 and 2  
 b) 1,2 and 3  
 c) 1,2,3 and 4  
 d) 1,2,3,4 and 5
- 8) Among electric field (**E**), magnetic field (**B**), angular momentum (**L**), and vector potential (**A**), which is/are odd under parity (space inversion) operation?
- a) **E** only  
 b) **E** & **A** only  
 c) **E** & **B** only  
 d) **B** & **L** only
- 9) The expression for the second overtone frequency in the vibrational absorption spectra of a diatomic molecule in terms of the harmonic frequency  $\omega$  and anharmonicity constant  $x_e$ , is
- a)  $2\omega_e(1 - x_e)$   
 b)  $2\omega_e(1 - 3x_e)$   
 c)  $3\omega_e(1 - 2x_e)$   
 d)  $3\omega_e(1 - 4x_e)$
- 10) Match the physical effects and order of magnitude of their energy scales given below, where  $\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c}$  is the fine structure constant,  $m_e$  and  $m_p$  are the electron and proton masses, respectively.

Group I	Group II
P: Lamb shift	1 : $\sim 0 (\alpha^2 m_e c^2)$
Q: Fine structure	2 : $\sim 0 (\alpha^4 m_e c^2)$
R: Bohr energy	3 : $\sim 0 \left( \frac{\alpha^4 m_e^2 c^2}{m_p} \right)$
S: Hyperfine structure	4 : $\sim 0 (\alpha^5 m_p c^2)$

- a)  $P - 3, Q - 1, R - 2, S - 4$   
 b)  $P - 2, Q - 3, R - 1, S - 4$   
 c)  $P - 4, Q - 2, R - 1, S - 3$   
 d)  $P - 2, Q - 4, R - 1, S - 3$
- 11) The logic expression  $\bar{A}BC + \bar{A}\bar{B}C + A\bar{B}\bar{C} + A\bar{B}C$  can be simplified to
- a)  $AXORC$   
 b)  $AANDC$   
 c) 0  
 d) 1
- 12) At low temperatures ( $T$ ), the specific heat of common metals is described by (with  $\alpha$  and  $\beta$  as constants)
- a)  $\alpha T + \beta T^3$   
 b)  $\beta T^3$   
 c)  $\exp\left(-\frac{\alpha}{T}\right)$   
 d)  $\alpha T + \beta T^5$
- 13) In a 2-to-1 multiplexer as shown below, the output  $X = A_0$  if  $C = 0$  and  $X = A_1$  if  $C = 1$ .



implementation of this multiplexer?

