الامتحان التنافسي للمتقدمين للدراسات العليا (الدكتوراه) لقسم الفيزياء-كلية العلوم
جامعة بغداد للعام الدراسي ٢٠١٦-٢٠١٧

الاختصاص: فيزياء الليزر والجزيئية

اولاً:الورقة العامة ٢٠%

1- Multiple Choice Questions:

Q.1) A baseball has a mass of 0.145kg. The resultant force required to given this baseball an acceleration of $400m/sec^2$ is: **a)** 85N,   **b)** 58 N,   **c)** 77 N,   **d)** 60 N.

Q.2) An electric motor exerts a force of 400N on a cable and pulls it a distance of 30m in 1 min. the power supplied by the motor is : **a)** 200 watt,   **b)** 150 watt,   **c)** 300 watt,   **d)** 234 watt.

Q.3) The Hamilton's function for one-dimension harmonic oscillator is:

a) $H = \frac{p^2}{2m} + \frac{k}{2}x^2$,   **b)** $H = \frac{m}{2}v^2 + \frac{k}{2}x^2$,   **c)** $H = \frac{p^2}{2m} - \frac{k}{2}x^2$,   **d)** $H = \frac{m}{2}v^2 - \frac{k}{2}x^2$.

Q.4) The diffraction condition is -----------------
  a) $\Delta K = G$ **b)** $(K+G)^2 = K^2$ **c)** $K^2 = K'^2$ **d)** $K + G = K`$

Q.5) Bragg law satisfied only for wavelength
  a) $\lambda = 2d$ **b)** $\lambda \leq 2d$ **c)** $\lambda \geq 2d$ **d)** $\lambda = d$

Q.6) There are ----------------- units of NaCl
  a) eight   **b)** four   **c)** three   **d)** two

Q.7) Matrix which does not have an inverse by solving it, is classified as
  a) unidentified matrix **b)** linear matrix   **c)** non-singular matrix   **d)** singular matrix

Q.8) According to determinant properties, multiple of one row is added to another row then determinant
  a) changed   **b)** unchanged   **c)** multiplied   **d)** added   **e)** singular matrix

Q.9) $Cosh^{-1}x =$
  a) $\ln(x+\sqrt{x^2+1})$ **b)** $\ln(x+\sqrt{(x^2+1)})$ **c)** $\frac{1}{2}\ln(1+x/1-x)$ **d)** $\frac{1}{2}\ln(x+1/x-1)$

Q.10) The unit of angular momentum is:
  a) $\hbar$ **b)** $\hbar/2$ **c)** $n\hbar$ **d)** $\hbar^2$

Q.11) Which of the following relations are correct for the angular momentum representation

a) $L^2 |lm> = h^2(l+1)|lm>$ **b)** $L^2 |lm> = h^2 l |lm>$

c) $L^2 |lm> = h^2 |lm>$ **d)** $L^2 |lm> = h^2(l^2)|lm>$

Q.12) Hydrogen like atom represented according to one of the following frame of reference

  a) (r, θ, Φ) **b)** (r, θ, z) **c)** (x, y, z) **d)** $(q_1, q_2, q_3, \ldots\ldots q_n)$

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Qualifying Examination
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2- Short Note Questions:

Q.1) A pendulum bob with a weight of 20N hangs from a cord. A horizontal force sufficient to bring the cord to an angle of 25^0 with the vertical is applied to the bob. Find the tension in the cord?

Q.2) A ball is thrown horizontally with a velocity of 50ft/sec from a tower 100ft high. Find the time of flight?

Q.3) Write briefly about geometrical structure factor

Q.4) Write briefly about Brillouin zone

Q.5) Find the area of a parallelogram whose adjacent are $\hat{i} - 2\hat{j} + 3\hat{k}$ and $2\hat{i} + \hat{j} - 4\hat{k}$.

Q.6) Express $\cos^6 \theta$ in multiple angeles.

Q.7) Given that in harmonic oscillator system in one dimension $\Psi_n = \frac{1}{\sqrt{n!}} (a^+)^n \Psi_0$

Rewrite this equation to produce Ψ_5 and find Ψ_5 in term of Ψ_3

Q.8) the orbital angular momentum quantum number (ℓ) has a projection quantum number (m_ℓ), then if $\ell = 3$ find the possible values of m_ℓ

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2 Multiple Choice Question:

Q.1) Intense light in laser action is :
(a) reduced gain.   (b) reduces the population inversion. (c) increase the population inversion. (d) increase gain.

Q.2) Which of the following would be a polar molecule?
(a) PCl_5 (b) BF_3 (c) $SiCl_4$ (d) PCl_3 (e) $BeCl_2$

Q.3) In atomic absorption spectroscopy,
(a) A photon is emitted causing an electron to fall from one atomic energy level to another
(b) A photon is absorbed causing an electron to fall from one atomic energy level to another
(c) A photon is emitted causing an electron to rise from one atomic energy level to another
(d) A photon is absorbed causing an electron to rise from one atomic energy level to another
(e) An electron is emitted causing a photon to rise from one atomic energy level to another

Q.4) Give the number of translational, rotational and vibrational degrees of freedom for a water molecule.
(a)3.3   (b)6.6   (c)9.9   (d)4.4   (e)5.5

Q.5) When the green one is dead, I have a red laser pointer that emits light with a wavelength of 670 nm. What is the energy of this light?
(a) 2.97 J mol^{-1} (b) 179 kJ   (c) 1.79 kJ mol^{-1} (d) 3.8 kJ mol^{-1}
(e) 17.9 J   (f) 17.9 kJ mol^{-1} (g) 2.97 kJ mol^{-1} (h) 179 J mol^{-1}
(i) 179 kJ mol^{-1} (j) 297 J mol^{-1}

Q.6) If you shine green light (λ = 520 nm) on a material, what is the most likely response of the molecules in that material to this wavelength of light?
(a) electronic transition   (b) nuclear spin flip   (c) bond stretch
(d) bending vibration   (e) bond rotation   (f) bond dissociation
(g) ionization   (h) photon emission

Q.7) A molecule has a fundamental frequency for one vibration of 995 cm^{-1} that shows rotational fine structure with spacing between the rotational lines of 3.0 cm^{-1}.
(a) 1013   (b) 1007   (c) 1004   (d) 998 E: 995
(f) 992   (g) 986   (h) 983   (i) 977 J: 959

Q.8) How many orbitals are present in the n=8 shell?
(a) 8   (b) 16   (c) 24   (d) 32   (e) 48   (f) 64

Q.9) How is the wavelength controlled in an FTIR spectrometer?
(a) By a Michelson Interferometer (b) By a computer (c)By a laser (d) By calibration with a standard sample

Q.10) In what region of the spectrum does infrared radiation occur?
(a) At the low-energy end   (b) Between the visible and ultraviolet regions
(c) Between the visible and microwave regions   (d) Between the visible and x-ray regions
(e) At the high-energy end

Q.11) What occurs when a molecule absorbs infrared radiation?
(a). It warms up   (b) It flies around   (c)It spins faster   (d) It vibrates faster   € It emits light

Q.12) What is the correct way to display spectra?
(a) In absorbance.   (b) In transmission.   (c) Either absorbance or transmission   (d)As raw data.

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2 Short Note Questions

Q.1)What portion of the electromagnetic spectrum induces the nuclear spin flip that occurs to generate an NMR spectrum?

Q.2) How many sigma (σ) and pi (π) bonds are present in the entire molecule C_2H_4?: _____ sigma bonds ____pi bonds

Q.3) Answer each of the following:

  i) Spectral Region for Molecular Electronic Transitions ----------------

  ii) Spectral Region for Molecular Vibrational Transitions ----- --------------

iii) Spectral Region for Molecular Rotational Transitions -------------

Q.4) Line broadening reduces the effective gain because ------------all atoms are capable of interacting with the radiation field

Q.5) In the fig. below describe the parameters in the lasing cycle of the 4-Level System:
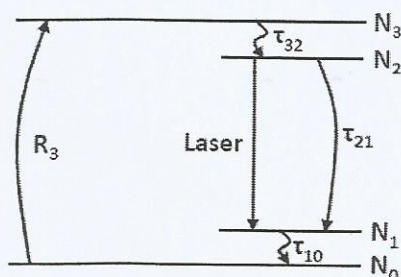
Q.6) There are many efficiencies in common use in laser physics write it and explain.

Q.7). What are the essential components of a laser system. Explain it.
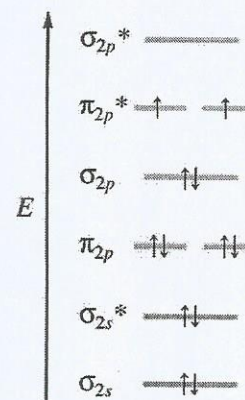
Q.8) The fig. in the right describes one molecule:
What is the molecule with this molecular orbital diagram?
What is the bond order? Is it paramagnetic or diamagnetic?