

八十七學年度 生命科學系 系(所)分生組丙 組碩士班研究生入學考試

科目 近代物理

科號 0902 共 2 頁第 1 頁 請在試卷【答案卷】內作答

答題時請列出計算過程，並將單位放入。

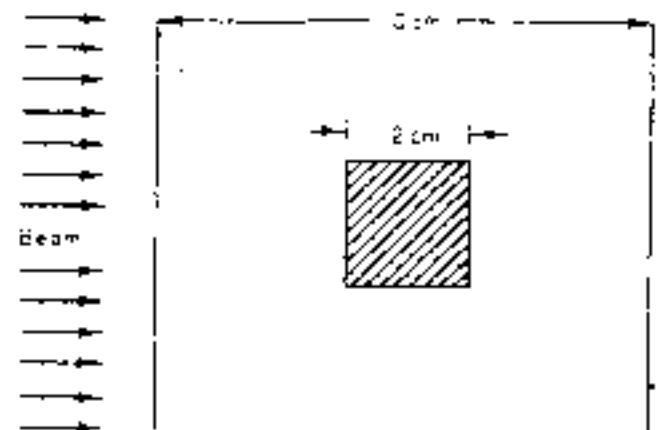
1. (5%) (a) Calculate the numerical value of the Bohr radius of a hydrogen atom.
(15%) (b) The 1s wave function of a hydrogen-like atom is

$$\psi_{1s} = 2 (Z/a_0)^{3/2} \exp(-2Zr/a_0)$$

where Z is the atomic number, and a_0 is the Bohr radius of hydrogen atom. What is the expectation value of the 1s electron radius?

2. (20%) Describe an experimental evidence of wave property of the electrons. Please include the experimental set up, the electronic circuitry, etc. What is the energy of the electrons in the experiment? Calculate the corresponding de Broglie wavelength.

3. (20%) Muscle and bone are arranged as shown. The density of muscle is 1.0 g cm^{-3} and the density of bone is 1.8 g cm^{-3} . With a 60keV X-ray, the attenuation coefficients are $0.200 \text{ cm}^2\text{g}^{-1}$ for the muscle and $0.274 \text{ cm}^2\text{g}^{-1}$ for the bone. Compare the intensity of the emerging X-ray which pass through the bone-muscle combination and just 10 cm of muscle.



4. (20%) (a) Describe the principle of the radiocarbon dating. Sample A of an ancient wood timber is analyzed for its ^{14}C content and gives 2.1 decays per minute. Another sample B of the same size from a recently cut tree of the same type gives 5.3 decays per minute. What is the age of sample A? The half-life of ^{14}C is 5730 yr. (b) Argue from statistical uncertainty why this method is unreliable to determine a sample of age older than 10 half-lives.
5. (20%) The skin temperature of a human body is 33°C . Assume that the human body surface area as 1.70 m^2 . Calculate the blackbody radiation rate from the body. Take the basal metabolic rate (body energy consuming rate) as 100 watts, what is a comfortable room temperature for this person if he is naked?

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Numerical values

$$N_A = 6.02 \times 10^{23} \text{ mole}^{-1}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$m_e = 9.11 \times 10^{-31} \text{ g} = 0.511 \text{ MeV}$$

$$c = 2.9979 \times 10^8 \text{ m s}^{-1}$$

$$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$$

$$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

$$\varepsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$h = 6.625 \times 10^{-34} \text{ J s}$$

x	exp (x)	ln (x)	log (x)
0.050	1.0513	-2.9957	-1.3010
0.100	1.1052	-2.3026	-1.0000
0.150	1.1618	-1.8971	-0.8239
0.200	1.2214	-1.6094	-0.6990
0.250	1.2840	-1.3863	-0.6021
0.300	1.3499	-1.2040	-0.5229
0.350	1.4191	-1.0498	-0.4559
0.400	1.4918	-0.9163	-0.3979
0.450	1.5683	-0.7985	-0.3468
0.500	1.6487	-0.6931	-0.3010
0.550	1.7333	-0.5978	-0.2596
0.600	1.8221	-0.5108	-0.2218
0.650	1.9155	-0.4308	-0.1871
0.700	2.0138	-0.3567	-0.1549
0.750	2.1170	-0.2877	-0.1249
0.800	2.2255	-0.2231	-0.0969
0.850	2.3396	-0.1625	-0.0706
0.900	2.4596	-0.1054	-0.0458
0.950	2.5857	-0.0513	-0.0223
1.000	2.7183	0.0000	0.0000
1.050	2.8577	0.0488	0.0212
1.100	3.0042	0.0953	0.0414
1.150	3.1582	0.1398	0.0607
1.200	3.3201	0.1823	0.0792
1.250	3.4903	0.2231	0.0969
1.300	3.6693	0.2624	0.1139
1.350	3.8574	0.3001	0.1303
1.400	4.0552	0.3365	0.1461
1.450	4.2631	0.3716	0.1614
1.500	4.4817	0.4055	0.1761