國立成功大學

113學年度碩士班招生考試試題

編　號：39

系　所：物理學系

科　目：近代物理學

日　期：0202

節　次：第 3 節

備　註：不可使用計算機

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※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

注意:可以用中文或英文作答。

Electric charge: $e = 1.6 \times 10^{-19}\ C$; Planck constant: $h = 6.63 \times 10^{-34}\ J \cdot s$

Speed of light: $c = 3 \times 10^{8}\ {}^{m}/_{s}$; Boltzmann constant: $1.38 \times 10^{-23}\ {}^{J}/_{K}$

(1-16 為單選題，每一題 5 分。請直接寫下選項，答錯不倒扣。)

1. A conclusion of the Michelson-Morley experiments was that (A) interference of EM-waves does not happen. (B) the ether doesn't exist. (C) Galilean relativity holds. (D) light has momentum. (E) light has no momentum.
2. The mean life of muons is 2.2 μs. How fast are they moving if their measured mean life is 1.1 μs? (A) 0.50 c (B) 0.87 c (C) 0.56 c (D) 0.94 c (E) This cannot happen.
3. A 1.00 mW laser produces photons of wavelength 633 nm. How many photons per second does the laser emit? (A) 6.33×10^{10} (B) 1.27×10^{12} (C) 3.18×10^{15} (D) 4.28×10^{16} (E) 1.60×10^{19}
4. A 100 keV photon undergoes Compton scattering. What is the greatest amount of kinetic energy that can be given to the electron in this process? (A) 100 keV (B) 71.8 keV (C) 83.6 keV (D) 28.2 keV (E) 16.4 keV
5. For the ion He^{+}, what is the energy of the ground state? (A) −13.6 eV (B) −27.2 eV (C) −54.4 eV (D) −6.80 eV (E) −3.40 eV
6. What is the energy of a photon that has the same wavelength as an electron with energy 1.60×10^{-15}J ? (A) 10.0 keV (B) 101 keV (C) 55.3 keV (D) 5.53 keV (E) 6.77 keV
7. Using the energy-time version of the uncertainty principle, estimate the uncertainty in energy of a state with lifetime 10^{-9} s. (A) 10^{-2} eV (B) 10^{-7} eV (C) 10^{-12} eV (D) 10^{-15} eV (E) 10^{-18} eV
8. The surface of the Sun is at a temperature of approximately 5800 K, and radiates a peak wavelength of 500 nm. According to the Planck radiation law, what is its emitted intensity per unit wavelength at the peak? (A) 8.4 $W/cm^2 \cdot nm$ (B) 42 $W/cm^2 \cdot nm$ (C) 84 $W/cm^2 \cdot nm$ (D) 8.4 $\times 10^3$ $W/cm^2 \cdot nm$ (E) 4.2 $\times 10^7$ $W/cm^2 \cdot nm$
9. If an element has a band gap of 1 eV between a filled valence band and an empty conduction band, it would be classified as a(n) (A) insulator. (B) conductor. (C) resistor. (D) semiconductor. (E) reactor.
10. Application of a forward bias to a *p-n* junction: (A) narrows the depletion zone (B) increases the electric field in the depletion zone (C) increases the potential difference across the depletion zone (D) increases the number of donors on the n side (E) decreases the number of donors on the n side
11. A situation known as "population inversion" is needed for lasing action. What does "population inversion" mean? (A) Electrons are in the -1/2 state. (B) Excited atoms must be at the top of the

laser tube. (C) Excited atoms must be at the bottom of the laser tube. (D) The number of excited states that are to emit photons are in greater number than the lower states at which the transition is ending. (E) The number of lower states are in greater number than the upper states participating in the lasing action.

12. Five electrons are in a two-dimensional square potential energy well with sides of length L. The potential energy is infinite at the sides and zero inside. The single-particle energies are given by $(h^2/8mL^2)(n_x^2 + n_y^2)$ where n_x and n_y are integers. The energy of the first excited state of the system is: (A) $13\ (h^2/8mL^2)$ (B) $22\ (h^2/8mL^2)$ (C) $24\ (h^2/8mL^2)$ (D) $25\ (h^2/8mL^2)$ (E) $27\ (h^2/8mL^2)$
13. Stellar cores, near the end of a star's lifetime, produce iron by fusion. The reason stellar cores don't go past iron is that (A) iron in stellar cores tends to spontaneously fission. (B) Iron is the most dense material in solid form (C) iron nuclei are the most tightly bound per nucleon. (D) iron is ferromagnetic. (E) iron is heavy.
14. A bound quark-antiquark pair is a _____ while a bound quark triplet is a _____. (A) beta particle; proton (B) neutron; meson (C) meson; baryon (D) baryon; meson (E) neutrino; antineutrino
15. The Z^0 boson is a mediator of weak interactions. It mass is $93\ \mathrm{GeV/c^2}$. About what is the range of this weak interaction? (A) $10^{-15}\ m$ (B) $10^{-18}\ m$ (C) $10^{-21}\ m$ (D) $10^{-24}\ m$ (E) $10^{-27}\ m$
16. A galaxy $200\ \mathrm{Mpc}$ from us has a recessional velocity of about $14{,}000\ \mathrm{km/s}$. If it emits radiation at a wavelength of $121\ \mathrm{nm}$, how much is that wavelength shifted when we observe it? (A) $5.7 \times 10^{-12}\ \mathrm{m}$ (B) $5.7 \times 10^{-10}\ \mathrm{m}$ (C) $5.7 \times 10^{-9}\ \mathrm{m}$ (D) $5.7 \times 10^{-7}\ \mathrm{m}$ (E) $5.7 \times 10^{-6}\ \mathrm{m}$

(17-20 為簡答題，每一題五分。請直接寫下答案，勿將計算過程寫在答案卷上。)

17. How many spectral lines appear in the Zeeman splitting of the $^2D_{3/2} \rightarrow {}^2P_{1/2}$ transition of sodium? _____
18. A large number of identical Fermi particles are confined in a box of volume V, occupying the lowest accessible levels. By what factor does the maximum momentum of the particles change if we double the volume of the box, leaving the number of particles unchanged? _____
19. A muon is a particle of mass $206m_e$ and charge equal to that of an electron. If a negative muon is captured by an atom of phosphorous $(Z = 15)$ and cascades down the various energy levels, what is the energy of a photon emitted by a transition of the muon between the $n = 3$ level and the $n = 2$ level? _____
20. Consider an atomic system consisting of an electron and positron bound to each other in a state of orbital angular momentum $l = 1$. What is the magnetic moment arising from the orbital motion? _____