國立成功大學

110學年度碩士班招生考試試題

編　號：93

系　所：材料科學及工程學系(綠色應用材料碩士班)

科　目：物理

日　期：0203

節　次：第 1 節

備　註：可使用計算機

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※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。
物理共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

1. Spacecraft-1 moves away from you with the speed of 0.50*c* relative to you. Spacecraft-2 also moves away from you along the same direction, but with the speed of 0.40c relative to Spacecraft-1. How fast is Spacecraft-2 relative to you? (*c* is speed of light).
(a) 0.10*c*　(b) 0.40*c*　(c) 0.65*c*　(d) 0.75*c*.

2. What is the change in entropy (J/K) of 250 g of steam at 100°C when it is condensed to water at 100°C? ($C_{steam} = 22.6\times10^5$ J/kg)
(a) -1500 J/K　(b) -150 J/K　(c) 0 J/K　(d) 150 J/K　(e) 1500 J/K.

3. A 660-Hz tuning fork has a total energy of 0.04 J. What is the ratio of its quantized energy to its total energy?
(a) ~10^{-27}　(b) ~10^{-33}　(c) ~10^{-29}　(d) ~ 10^{-31}　(e) ~ 10^{-30}.

4. One end of a long, thin rod of length *D* is fastened to the floor with a hinge. The free end is raised so the rod makes an angle θ with the horizontal, then released from rest. Find the linear speed *v* of the free end just before it strikes the floor.
(a) $\sqrt{1.5gD\sin\theta}$　(b) $\sqrt{3gD\sin\theta}$　(c) $\sqrt{6gD\sin\theta}$　(d) $\sqrt{12gD\sin\theta}$.

5. Two aluminum wires have the same resistance. If one has twice the length of the other, what is the ratio of the diameter of the longer wire to the diameter of the shorter wire?
(a) 0.64　(b) 1.00　(c) 1.41　(d) 1.78.

6. In the consideration of the Maxwell fourth equation, which of the following quantity is solenoidal in the electromagnetic theory?
(a) Magnetic flux density　(b) Electric flux density　(c) Magnetic field intensity (d) Electric field intensity.

7. A beam of initially unpolarized light is sent through two polarizing sheets placed one on top of the other. What must be the angle between the polarizing directions of the sheets if the intensity of the transmitted light is to be one-third the incident intensity?
(a) 35°　(b) 36°　(c) 37°　(d) 38°.

8. An ideal gas occupies 12 liters at 293K and 1 atm (76 cm Hg). Its temperature is now raised to 373K and its pressure increased to 215 cm Hg. The new volume is:
(a) 0.2 liters　(b) 5.4 liters　(c) 13.6 liters　(d) 20.8 liters.

9. Which of the following type of boundary would make the tangential component of an electric field continuous?
(a) Dielectric-Dielectric (b) Conductor-Conductor (c) Conductor-Dielectric (d) Any boundary.

10. The clocks in a moving S′ reference frame with a constant speed of V indicate a time interval of 1 minute, but the clocks in the rest frame S indicate the same time interval as 2 minutes. How fast is the frame S′ moving with respect to frame S? (*c* is speed of light)
(a) 0.866*c* (b) 0.750*c* (c) 0.677*c* (d) 0.525*c*.

11. A particle is limited to the x axis is described by $\Psi = (3x^2)^{1/2}$ for $0 \le x \le 1$ and $\Psi = 0$ elsewhere. The probability of finding the particle between x = 0.2 and x = 0.36 is
(a) 0.0563 (b) 0.0387 (c) 0.267 (d) 0.767 (e) 0.0289.

12. What is the radiation pressure 1.5 m away from a 500 W lightbulb? Assume that the surface on which the pressure is exerted faces the bulb and is perfectly absorbing and that the bulb radiates uniformly in all directions.
(a) 5.3×10^{-8} Pa (b) 5.5×10^{-8} Pa (c) 5.7×10^{-8} Pa (d) 5.9×10^{-8} Pa.

13. A charged insulator can be discharged by passing it just above a flame. This is because the flame:
(a) warms it (b) contains carbon dioxide (c) contains ions (d) contains more rapidly moving atoms.

14. A beam of polarized light is sent into a system of two polarizing sheets. Relative to the polarization direction of that incident light, the polarizing directions of the sheets are at angles θ for the first sheet and 90° for the second sheet. If 0.10 of the incident intensity is transmitted by the two sheets, what is θ ?
(a) 10° or 80° (b) 20° or 70° (c) 30° or 60° (d) 40° or 50°.

15. The Maxwell second equation that is valid in dielectric medium is which of the following?
(a) Curl(H) = Jd (b) Curl(H) = Jc (c) Curl(E) = Jd (d) Curl(E) = Jc.

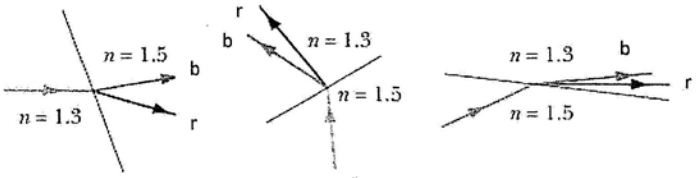
16. The magnetic quantum number describes
(a) Shape of the orbital
(b) Spatial orientation of the orbital
(c) Average distance of the most electron-dens regions from the nucleus
(d) Number of electrons
(e) The length of the orbital.

17. An electron has the kinetic energy of 486 eV. What is its de Broglie wavelength?
(a) 0.025 nm (b) 0.055 nm (c) 0.085 nm (d) 0.115 nm.

18. A uniform solid bowling ball (mass *M*, radius *R*) is launched in pure translation (without rotation) along the bowling alley floor with an initial speed v_0. During an initial distance *D*, it partially slides while gaining rotational speed, after which it rolls without slipping. The constant force of friction is *f*. In terms of the given symbols, **find the distance *D***.
(a) $12mv_0^2/(25f)$ (b) $12mv_0^2/(5f)$ (c) $12mv_0^2/(7f)$ (d) $12mv_0^2/(49f)$.

19. The two plates of a capacitor hold 2800 mC and -2800 mC of charge, respectively, when the potential difference is 930 V. The capacitance is _____ μF.
(a) 1.0 (b) 3.0 (c) 5.0 (d) 7.0.

20. Each part of the below figure shows light that refracts through an interface between two materials. The incident ray (shown gray in the figure) consists of red and blue light. The approximate index of refraction for visible light is indicated for each material. Which of the three parts show physically possible refraction? (a) a (b) b (c) c (d) none



(a) (b) (c)

21. If you travel at a speed of 2×10^8 m/s in the +x direction, then you will find the speed of light, in the –x direction, to be
(a) unknown (b) 1×10^8 m/s (c) 3×10^8 m/s (d) 5×10^8 m/s (e) None of the above.

22. The terminal potential difference of a battery is less than its emf:
(a) under all conditions (b) only when the battery is being charged
(c) only when the battery is being discharged (d) only when there is no current in the battery.

23. If the distance between the first and tenth minima of a double-slit pattern is 18.0 mm and the slits are separated by 0.150 mm with the screen 50.0 cm from the slits, what is the wavelength of the light used?
(a) 400 nm (b)500 nm (c) 600 nm (d) 700 nm (e) 800 nm.

24. Two identical batteries, each with an emf of 18V and an internal resistance of 1 Ω, are wired in parallel by connecting their positive terminals together and connecting their negative terminals together. The combination is then wired across a 4-Ω resistor. The potential difference across the 4-Ω resistor is:
(a) 4V (b) 8V (c) 14V (d) 16V.

25. If the *l*=3 orbital state is placed in a magnetic field, how many substates does it split into?
(a) 7 (b) 6 (c) 5 (d) 4.

26. A merry-go-round revolves at a constant angular speed of 0.50 rad/s in a counter-clockwise direction when viewed from above. A 40-kg rider walks tangentially (in the same direction the merry-go-round is moving) at a constant speed of 2m/s relative to the merry-go-round, maintaining a constant radius of 2m from the axis. Analyze the situation in the rotating frame to find **the magnitude and direction of the Coriolis force on the rider?**
(a)180N, radially outward (b)180N, radially inward (c)80N, radially outward (d)20N, radially outward.

27. What is the inductance of a coil if the coil produces an emf of -2.50 V when the current in it changes from 28.0 mA to 25.0 mA in 12.0 ms?
(a) 0.566 H (b) 5.66 H (c) 56.6 H (d) 566 H.

28. A model airplane whose mass is 0.75kg is tethered by a wire so that it flies in a circle 30m in radius. The airplane engine provides a trust of 0.80N perpendicular to the tethering wire. **Find the angular acceleration of the airplane when in level flight.**
(a) $3.56\times10^{-2}\ rad/s^2$ (b) $7.12\times10^{-2}\ rad/s^2$ (c) $3.56\times10^{-3}\ rad/s^2$ (d) $7.12\times10^{-3}\ rad/s^2$.

29. The bond length and reduced mass of CO are respectively 0.113 nm and $1.14\text{x}10^{-26}$ kg. What is the J=0 to J=1 absorption frequency for CO?
(a) $1.15\text{x}10^{10}$ Hz (b) $1.15\text{x}10^{12}$ Hz (c) $1.15\text{x}10^{14}$ Hz (d) $1.15\text{x}10^{11}$ Hz (e) $1.15\text{x}10^{13}$ Hz.

30. A sound source A and a reflecting surface B move directly toward each other. Relative to the air, the speed of source A is 29.9 m/s, the speed of surface B is 65.8 m/s, and the speed of sound is 329 m/s. The source emits waves at frequency 1200 Hz as measured in the source frame. In the reflector frame, what are the frequency and wavelength of the arriving sound waves?
(a) $f=1.64\times10^3$; $\lambda=0.0208$ m (b) $f=1.64\times10^3$; $\lambda=0.208$ m (c) $f=1.44\times10^3$; $\lambda=0.0208$ m
(d) $f=1.44\times10^3$; $\lambda=0.208$ m (e) $f=1.58\times10^3$ Hz; $\lambda=0.208$ m.

31. An inclined plane is fastened to a cart that is accelerating horizontally at $6m/s^2$. A mass is placed on the plane, where it remains at rest (in the cart's frame) even through the inclined plane is frictionless. What angle does the plane make with the horizontal?
(a) 31.5^o (b) 37.0^o (c) 45.0^o (d) 53.0^o.

32. Imaging that you are taking an elevator with a scale. If you are standing on the scale while the elevator moving, please find a general solution for the scale reading, whatever the vertical motion of the cab. Assume your mass is m, gravity acceleration is g and the position of cab is $y(t)$.
(a) $m(g+y)$ (b) $m(g+y')$ (c) $mg+y''$ (d) $m(g+y'')$.

33. Estimate the magnetic energy of an electron in the 2p state of a hydrogen atom.
(a) 10^{-10} eV (b) 10^{-30} J (c) 10^{-15} eV (d) 10^{-10} J (e) 10^{-5} eV.

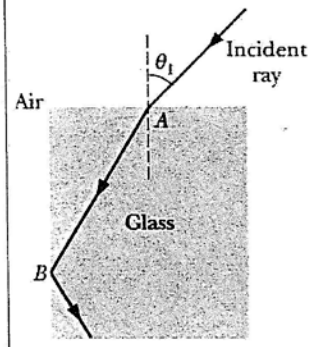
34. In the hydrogen atom, the electron and proton are separated by $5\times10^{-11}m$. If the only force between them were gravitational, what would be the period of revolution of the electron orbiting around the proton? Their masses are $m_e=9.11\times10^{-31}kg$ and $m_p=1.67\times10^{-27}kg$.
(a) 0.7year (b) 1.4year (c) 0.07year (d) 0.14year.

35. The Maxwell first law is based on which of the following law(s)?
(a) Lenz law (b) Faraday law (c) Ampere law (d) Faraday and Lenz law.

36. A slit 1.00 mm wide is illuminated by light of wave-length 600 nm. We see a diffraction pattern on a screen 3.00 m away. What is the distance between the first two diffraction minima on the same side of the central diffraction maximum?
(a) 3.0×10^{-3} m (b) 1.0×10^{-3} m (c) 2.0×10^{-3} m (d) 3.6×10^{-3} m (e) 1.8×10^{-3} m.

37. In a medium other than air, the electric flux density will be which of the following
(a) solenoidal (b) Divergent (c) Irrotational (d) Curl free.

38. In the below figure, a light ray enters a glass slab at point *A* at incident angle θ_1= 45.0° and then undergoes total internal reflection at point *B*. (The reflection at *A* is not shown.) What minimum value for the index of refraction of the glass can be inferred from this information?
(a) 1.22 (b) 1.23 (c) 1.24 (d) 1.25



39. An air-filled parallel-plate capacitor has a capacitance of 1 pF. The plate separation is then doubled and a wax dielectric is inserted, completely filling the space between the plates. As a result, the capacitance becomes 2 pF. The dielectric constant of the wax is:
(a) 0.5　(b) 2.0　(c) 4.0　(d) 8.0

40. What is the spin angular momentum of an electron? (h is Plank's constant).
(a) h/4π　(b) 3h/2π　(c) √3h/2π　(d) √3h/4π.

41. A string oscillates according to the equation y= (0.50 cm) sin[(π /3 cm^{-1})x] cos[(40 π s^{-1})t]. What are the speed of the two waves (identical except for direction of travel) whose superposition gives this oscillation, ν ? What is the distance between nodes, D?
(a) ν =60 m/s; D=6.0 m　(b) ν =60 m/s; D=12.0 m　(c) ν =120 m/s; D=6.0 m
(d) ν =240 m/s; D=6.0 m　(e) ν =120 m/s; D=3.0 m.

42. A wheel undergoes a constant angular acceleration $2 rad/s^2$. During a 3-s interval, the wheel turns through a total angular displacement of 90 rad. If the wheel started from rest, how long had it been turning before the beginning of the 3-s interval?
(a) 4.5-s　(b) 7.5-s　(c) 13.5-s　(d) 15-s.

43. A horizontal pipe 10cm in diameter has a smooth reduction to a pipe 5cm in diameter. If the pressure of the water in the large pipe is $8\times10^4 N/m^2$ and the pressure in the smaller pipe is $8\times10^4 N/m^2$, at what rate does water flow through the pipes?
(a) 12.8kg/s　(b) 128kg/s　(c) 6.4kg/s　(d) 64kg/s.

44. In the laser operation pumped by optical absorption, what is the minimum number of energy levels needed in order to achieve population inversion?
(a) 1　(b) 2　(c) 3　(d) 4

45. For a damped oscillator with mass $m\ (kg)$, force constant k (N/m) and damping factor b (kg/s). If $b^2 - 4mk < 0$, then what is the period of the motion?
(a) $2\pi\sqrt{\frac{m}{k}}$　(b) $2\pi\frac{2m}{\sqrt{4mk-b^2}}$　(c) $2\pi\frac{2m}{\sqrt{b^2-4mk}}$　(d) $2\pi\frac{m}{\sqrt{4mk-b^2}}$

46. To throw an $M\ (kg)$ opponent with a basic judo hip throw, you intend to pull his uniform with a force $F\ (N)$ and a moment arm $d_1\ (m)$ from a pivot point (rotation axis) on your right hip. You wish to rotate him about the pivot point with an angular acceleration $\alpha\ (rad/s^2)$. Assume that his rotational inertia relative to the pivot point is $I\ (kg \cdot m^2)$ and the distance between your hip to his hip is $d_2\ (m)$ What must the magnitude of force, $F\ (N)$, be?
(a) $\frac{I\alpha}{d_1}+\frac{d_2Mg}{d_1}$　(b) $-\frac{I\alpha}{d_1}+\frac{d_2Mg}{d_1}$　(c) $-\frac{I\alpha}{d_2}+\frac{d_2Mg}{d_1}$　(d) $\frac{I\alpha}{d_2}+\frac{d_2Mg}{d_1}$

47. At extremely low temperature, i.e. T → 0 K, the contribution to the specific heat of solids mainly come from:
(a) electrons　(b) lattice vibration　(c) equally from both electrons and lattice vibration
(d) none of above.

48. A race car driver collides his car with the racetrack wall. Just before the collision, he is traveling at speed $v_i = 70\ m/s$ along a straight line at 30° from the wall. Just after the collision, he is traveling at speed $v_f = 50\ m/s$ along a straight line at 10° from the wall. His mass m is $80\ kg$. What is the impulse on the driver due to the collision?
(a) $910\ kg \cdot m/s$　(b) $3500\ kg \cdot m/s$　(c) $3616\ kg \cdot m/s$　(d) $4410\ kg \cdot m/s$.

49. Bats navigate and search out prey by emitting, and then detecting reflections of, ultrasonic waves, which are sound waves with frequencies greater than can be heard by a human. Suppose a bat emits ultrasound at frequency $f_b = 82.52\ kHz$ while flying with velocity $v_b = 9.0i\ m/s$ as it chases a moth that flies with velocity $v_m = 8.0i\ m/s$. The speed of sound is $343\ m/s$. What frequency does the bat detect in the returning echo from the moth?
(a) $82.52\ kHz$　(b) $82.76\ kHz$　(c) $82.81\ kHz$　(d) $83.00\ kHz$.

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50. A wave has an angular frequency of 110 rad/s and a wave-length of 1.80 m. Calculate the angular wave number, K, and the speed of the wave, ν.

(a) K=3.48 m^{-1}; ν =31.51 m/s　(b) K=0.55 m^{-1}; ν =31.51 m/s　(c) K=3.48 m^{-1}; ν =61.11 m/s

(d) K=3.48 m^{-1}; ν =63.05 m/s　(e) K=1.11 m^{-1}; ν =31.51 m/s.