國立成功大學 104 學年度碩士班招生考試試題

系所組別：材料科學及工程學系

考試科目：普通物理

考試日期：0211，節次：1

※ 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。

普通物理共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.4 分；滿分 100 分，倒扣至 0 分為止。

1. Two identical small charged spheres are a certain distance apart, and each initially experiences an electrostatic force of magnitude F due to the other. When each of the spheres has lost half its initial charge, the magnitude of the electrostatic force will be

(a) 1/8 F
(b) 1/16 F
(c) 1/4F
(d) 1/2 F
(e) same force

2. A charged capacitor is connected across a 10-kΩ resistor and allowed to discharge. The potential difference across the capacitor drops to 0.37 of its original value after a time of 7.0 s. What is the capacitance of the capacitor?

(a) 1.89 mF
(b) 0.19 mF
(c) 0.70 mF
(d) 0.37 mC
(e) 0.7 mC

3. A negatively charged rod is brought near one end of an uncharged metal bar. The end of the metal bar farthest from the charged rod will be charged

(a) negative
(b) positive
(c) neutral
(d) No charge is flowing
(e) none of the given answers

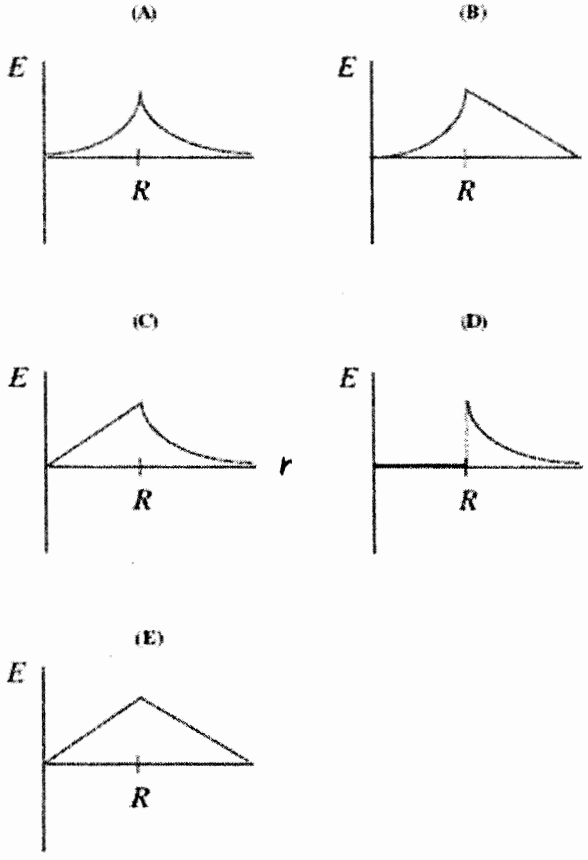
4. An electric Field is most directly related to:

(a) the momentum of a test charge
(b) the kinetic energy of a test charge
(c) the potential energy of a test charge
(d) the force acting on a test charge
(e) the charge carried by a test charge

5. A square metal plate of 8cmx8cm has a total charge of $6x10^{-6}$C. What is the electric field close to the surface assuming uniform charge distribution over both sides?

(a) $5x10^{7}V/m$
(b) $5x10^{3}V/m$
(c) $5V/m$
(d) $5x10^{-3}V/m$
(e) $5x10^{10}V/m$

6. A solid conducting sphere has radius R and carries positive charge Q. Which of the following graphs represents the electric field E as a function of the distance r from the center of the sphere?



7. A body of mass *m*, suspended from a spring with a force constant *k*, vibrates with a frequency f_1. When the spring is cut in half and the same body is suspended from one of the halves, the frequency is f_2. $f_2 / f_1 =$

(a) $\sqrt{2}$
(b) $1/\sqrt{2}$
(c) 2
(d) 4
(e) 1

8. A solid cylinder rolls without slipping down a 30° slope. Find the minimum coefficient of friction needed to prevent slipping.

(a) $\sqrt{3}$
(b) $1/\sqrt{3}$
(c) $1/(2\sqrt{3})$
(d) $1/(3\sqrt{3})$
(e) $2/(3\sqrt{3})$

9. A rectangular block 0.25m wide and 0.5m height is dragged to the right along a level surface at constant speed by a horizontal force P (acting on the right side of the block with height *h* above the level surface). Find the value of h at which the block just starts to tip.

(a) 0.4375m
(b) 0.3125m
(c) 0.1375m
(d) 0.0375m
(e) 0.15m

10. A body of mass 600g is initially at rest. It is struck by a second body of mass 400g initially moving with a velocity of 125cm/s toward the right along the x-axis. After the collision, the 400-g body has a velocity of 100cm/s at an angle 37° above the x-axis in the first quadrant. Both bodies move on a horizontal frictionless plane. What is the magnitude and direction of the velocity of the 600-g body after collision?

(a) 50cm/s, 53.1° above the x-axis
(b) 50cm/s, 53.1° below the x-axis
(c) 125cm/s toward the right along the x-axis
(d) 50cm/s toward the right along the x-axis
(e) 50cm/s, 30° above the x-axis

11. A tennis ball approaches a player's racket horizontally at 10m/s. After it is struck its velocity is horizontal, in the opposite direction, with magnitude 20m/s. The ball has mass 0.060kg, and it is in contact with the racket for 0.01s. What is the average force acted on the ball.

(a) 36N
(b) 360N
(c) 18N
(d) 180N
(e) 1.8N

國立成功大學 104 學年度碩士班招生考試試題

系所組別：材料科學及工程學系

考試科目：普通物理

考試日期：0211，節次：1

12. A particle is undergoing a constant acceleration while the position and time are recorded. The data shows time ***t*** (s) and position ***x*** (m) in the following ***t(x)*** format: 0(0), 1(2), 4(32). What is the distance of travel of this particle in the 4^{th} second?

(a) 18 m
(b) 14 m
(c) 32 m
(d) 25 m
(e) 8 m

13. Two buses are travelling toward each other on a straight road. The Blue bus moves southbound at 8 m/s, while the Red bus moves northbound at 16 m/s. They both apply the brakes when they see each other when are 45 m apart; Blue bus slows down at 4 m/s^2, while the Red bus slows down at 2 m/s^2. When do they collide?

(a) 2.8 s
(b) 13.2s
(c) 3 s
(d) 5.4 s
(e) 1.6 s

14. Continued from the previous question, how much farther does the Blue bus travel before the collision?

(a) 3 m
(b) 10 m
(c) 4 m
(d) 5 m
(e) 8 m

15. A rolling rubber wheel on a concrete road is subject to rolling friction. Which of the following is not one of the causes?

(a) diameter of wheel
(b) adhesion force at contact
(c) gravity of wheel
(d) deformation at contact
(e) elastic hysteresis of wheel

16. In 2012, Austrian skydiver Felix Baumgartner achieved his world-record-breaking jump from space. He reached a maximum speed of about 1,342 km/h during free fall. What is the reason for his maximum speed limit?

(a) weight
(b) air friction
(c) temperature
(d) earth's rotation
(e) Coriolis effect

17. Add one mole of water to a large quantity of water, the volume change is 18 cm^3. Now we add one mole of water to a large quantity of ethanol, the volume change becomes 14 cm^3. Therefore, we know:

(a) For water-ethanol solution, water is solvent.
(b) Ethanol-water bonds are weaker than water-water bonds.
(c) Water-ethanol solution is not Raoultian.
(d) In the water-ethanol solution, the water molecules stick together.
(e) The volume change can be calculated using $$\Delta \overline{V}_i^M = \left(\frac{\partial \Delta \overline{G}_i^M}{\partial X_i} \right)_{T,Comp.}$$

18. Charge is distributed uniformly on the surface of a large flat plate. The electric field 2 cm from the plate is 30N/C. The electric field 4 cm from the plate is:

(a) 120N/C
(b) 80N/C
(c) 30N/C
(d) 15N/C
(e) 7.5N/C

19. A particle with a charge of 5.5×10^{-8}C is fixed at the origin. A particle with a charge of -2.3×10^{-8} C is moved from x = 3.5 cm on the x axis to y = 4.3 cm on the y axis. The change in potential energy of the two-particle system is:

(a) 3.1×10^{-3} J
(b) -3.1×10^{-3} J
(c) 6.0×10^{-5} J
(d) -6.0×10^{-5} J
(e) 0

20. The potential difference between two points is 100V. If a particle with a charge of 2C is transported from one of these points to the other, the magnitude of the work done is:

(a) 200 J
(b) 100 J
(c) 50 J
(d) 20 J
(e) 2 J

21. A car battery is rated at 80A · h. An ampere-hour is a unit of:
(a) power
(b) energy
(c) current
(d) charge
(e) force

22. Electrical current is a measure of:
(a) force that moves a charge past a point
(b) resistance to the movement of a charge past a point
(c) energy used to move a charge past a point
(d) amount of charge that moves past a point per unit time
(e) speed with which a charge moves past a point

23. Which class of materials has the highest energy gap
(a) superconductor
(b) dielectric materials
(c) conductor
(d) semi-metal
(e) semiconductor

24. In quantum mechanics, which of the following boundary conditions can be used to derive the energy levels of bonding in crystalline materials
(a) finite square potential well
(b) a potential barrier with a narrow width
(c) parabolic potential well
(d) Coulomb's static electrical potential well
(e) a potential barrier with finite height and width

25. For the Fermi-Dirac statistical distribution, which of the following statement is incorrect?

(a) particles obey exclusion principle
(b) particles are distinguishable
(c) spin quantum number equals 1/2, 3/2, 5/2, ...
(d) particles are treated as identical
(e) electron particles will follow FD distribution

26. In the emission spectrum of atoms, certain transitions between energy levels have higher probabilities of occurrence than others. This can be attributed to
(a) uncertainty principle
(b) special relativity
(c) correspondence principle
(d) exclusion principle
(e) selection rule

27. The energy dispersive spectroscopy (EDS) is frequently installed in a scanning electron microscope (SEM) to provide qualitative and semi-quantitative analysis. The operation principle of EDS is originated from who's finding.
(a) Rutherford
(b) Davisson and Germer
(c) Zener
(d) Moseley
(e) Zeeman

28. A sinusoidal wave with an amplitude of 1.0 cm and a frequency of 100 Hz travels at 200 m/s in the positive x-direction. At t=0 s, the point x=0 m is on a crest of the wave. Which one of the following functions can describe the wave mentioned above?
(a) $\sin(\pi x - 200\pi t)$
(b) $\cos(\pi x - 200\pi t)$
(c) $\cos(\pi x + 200\pi t)$
(d) $\sin(\pi x - 200\pi t + \frac{2\pi}{3})$
(e) $\cos(\pi x - 100\pi t)$

29. A police siren has a frequency of 550 Hz as the police car approaches you, 450 Hz after it has passed you and is receding. How fast are the police traveling? [The velocity of the sound is 343 m/s]
(a) 14.3 m/s
(b) 24.3 m/s

(c) 34.3 m/s
(d) 44.3 m/s
(e) 54.3 m/s

30. A helium-neon laser, the kind that provides the familiar red light of classroom demonstrations and supermarket checkout scanner, emits 1.0 mW of light power into a laser beam that is 1.0 mm in diameter. What is the intensity of the laser beam?

(a) 1000 W/m^2
(b) 1100 W/m^2
(c) 1200 W/m^2
(d) 1250 W/m^2
(e) 1350 W/m^2

31. Orange light with a wavelength of 600 nm is incident upon a 1.00-mm-thick glass microscope slide. What is the light speed in the glass? [The index of refraction of the glass is 1.5]

(a) 3.00×10^8 m/s
(b) 2.80×10^8 m/s
(c) 2.60×10^8 m/s
(d) 2.40×10^8 m/s
(e) 2.00×10^8 m/s

32. Which one of the following statement is correct?

(a) The reason that we can not see an atom by naked eyes is due to human's pupil is too small.
(b) Given enough light intensity human should be able to see an atom by naked eyes.
(c) The reason that we can not see an atom by naked eyes is due to our eyes do not have such resolution.
(d) If there is an optical device which can magnify the image to great extend, then we should be able to see an atom.
(e) The reason that we can not see an atom is due to the wavelength of light is too large.

33. If the l=2 orbital state is placed in a magnetic field, how many substates does it split into?

(a) 1
(b) 2
(c) 3
(d) 4
(e) 5

34. If the Bohr radius is 0.053 nm, what is the radius for the 2^{nd} excited state of hydrogen atom?

(a) 0.106 nm
(b) 0.212 nm
(c) 0.477 nm
(d) 0.848 nm
(e) 1.00 nm

35. A photon can be materialized into an electron and a positron. This process is called as "pair production" and cannot happen with the photon of blue light because
(a) the photon of blue light does not have enough energy.
(b) blue light can be seen by human eyes.
(c) blue light is easy to be scattered by air.
(d) blue light is not easily available.
(e) none of above.

36. A person on the ground switches on a blue laser. What is the speed of the blue light for the observer in a spacecraft traveling at 0.8C? (C is the speed of light in free space).
(a) 0.2C
(b) 0.4C
(c) 0.8C
(d) C
(e) 2C

37. The length of a spacecraft appears to be 80% of its original length for an observer on the earth. What is the speed of the spacecraft? (C is the speed of light in free space).
(a) 0.5C
(b) 0.6C
(c) 0.7C
(d) 0.8C
(e) 0.9C

38. A negative charge that is free to move but is at rest in an electrical field will
(a) accelerate in the direction perpendicular to the direction of the field.
(b) remain at rest.
(c) accelerate in the direction opposite to the direction of the field.
(d) accelerate in the same direction as the field.
(e) do none of the above.

39. A uniform circular ring has charge Q and radius r. The magnitude of the electric field at a distance of r along the axis of the ring is E_o. If the radius were to double, then calculate the new electric field at a distance of r along the axis of the ring in terms of E_o.

(a) 0.40 E_o
(b) 0.25 E_o
(c) 0.50 E_o
(d) 0.20 E_o
(e) 0.089 E_o

40. A solid sphere of radius a is concentric with a hollow sphere of radius b, where b > a. If the solid sphere has a charge +Q and the hollow sphere a charge of –Q, the electric field at radius r, where a < r < b, is which of the following, in terms of $k = (4\pi\in 0)^{-1}$?

(a) kQ/r^2
(b) $2kQ/r^2$
(c) kQ/a^2
(d) kQ/b^2
(e) $kQ/(b-a)^2$

41. A charge of 2.0 mC is located in a uniform electric field of intensity 4.0×10^5 N/C. How much work is required to move this charge 20.0 cm along a path making an angle of 60.0° with the electric field?

(a) 0.14 J
(b) 0.34 J
(c) 80 mJ
(d) 14 J
(e) 8.0 J

42. If you increase the charge on a parallel-plate capacitor from 3 μC to 9 μC and increase the plate separation from 1 mm to 3 mm, the energy stored in the capacitor changes by a factor of

(a) 27
(b) 9
(c) 3
(d) 8
(e) 1/3

43. The capacitance of a parallel-plate capacitor is 24 μF when the plates are separated by a material of dielectric constant 2.0. If this material is removed, leaving air between the plates, and the separation between the plates is tripled, the capacitance is

(a) unchanged
(b) 16 μF
(c) 36 μF
(d) 0.14 mF
(e) 4.0 μF

44. An egg, initially at rest, is dropped onto a concrete surface and breaks. With the egg treated as the system, what is the sign of ΔE_P? (Given: $\Delta U + \Delta E_P + \Delta E_K = Q - W$)
(a) positive
(b) negative
(c) zero
(d) information insufficient
(e) none of above is correct

45. An egg, initially at rest, is dropped onto a concrete surface and breaks. With the egg treated as the system, what is the sign of ΔE_K? (Given: $\Delta U + \Delta E_P + \Delta E_K = Q - W$)
(a) positive
(b) negative
(c) zero
(d) information insufficient
(e) none of above is correct

46. An egg, initially at rest, is dropped onto a concrete surface and breaks. With the egg treated as the system, what is the sign of ΔU? (Given: $\Delta U + \Delta E_P + \Delta E_K = Q - W$)
(a) positive
(b) negative
(c) zero
(d) information insufficient
(e) none of above is correct

47. An egg, initially at rest, is dropped onto a concrete surface and breaks. With the egg treated as the system, what is the sign of Q? (Given: $\Delta U + \Delta E_P + \Delta E_K = Q - W$)
(a) positive; absorb from the environment
(b) positive; desorb to the environment
(c) zero
(d) negative; absorb from the environment
(e) negative; desorb to the environment

國立成功大學 104 學年度碩士班招生考試試題

系所組別：材料科學及工程學系

考試科目：普通物理

考試日期：0211，節次：1

48. At constant pressure
(a) enthalpy is equivalent to work
(b) enthalpy is equivalent to internal energy
(c) enthalpy is equivalent to Gibbs free energy
(d) enthalpy is equivalent to heat
(e) enthalpy is equivalent to entropy

49. Which of the following is an insensitive property?
(a) enthalpy
(b) entropy
(c) volume
(d) Helmholtz free energy
(e) density

50. For a system at constant T and P, which of the following is the criterion of equilibrium?
(a) dA=0
(b) dS=0
(c) dU=0
(d) dH=0
(e) dG=0