

一．單選題（共二十五題，每題二分）

1. The displacement of a moving object can be obtained from:
 - (a) the slope of an acceleration-time graph
 - (b) the slope of a velocity-time graph
 - (c) the area under an acceleration-time graph
 - (d) the area under a velocity-time graph
2. Vectors \vec{A} and \vec{B} each have magnitude L . If their tails are at the same point, the angle between them is 30° . The magnitude of $\vec{A} \times \vec{B}$ is
 - (a) $L^2/2$
 - (b) L^2
 - (c) $\sqrt{3}L^2/2$
 - (d) $2L^2$
3. A 90-kg man stands in an elevator that has a downward acceleration of $1.4m/s^2$. The force exerted by him on the floor is about:
 - (a) 90 N
 - (b) 760 N
 - (c) 880 N
 - (d) zero
4. A kilowatt-hour is a unit of:
 - (a) power
 - (b) energy/time
 - (c) work
 - (d) power/time
5. When a thin uniform stick of mass M and length L is pivoted about its midpoint, its rotational inertia is $ML^2/12$. When pivoted about a parallel axis through one end, its rotational inertia is:
 - (a) $ML^2/12$
 - (b) $ML^2/6$
 - (c) $ML^2/3$
 - (d) $7ML^2/12$
6. An astronaut in an orbiting spacecraft feels "weightless" because she:
 - (a) is beyond the range of gravity
 - (b) is pulled outwards by centrifugal force
 - (c) has no acceleration
 - (d) has the same acceleration as the spacecraft
7. A wooden board floats in fresh water with 60% of its volume under water. The density of the wood in g/cm^3 is:
 - (a) 0.4
 - (b) less than 0.4
 - (c) 0.6
 - (d) more than 0.6
8. A 0.25-kg block oscillates on the end of the spring with a spring constant of 200 N/m. If the system has an energy of 6.0 Joules, then the maximum speed of the block is:
 - (a) 0.06 m/s
 - (b) 0.17 m/s
 - (c) 4.9 m/s
 - (d) 6.9 m/s
9. The displacement of a string is given by

$$y(x, t) = y_0 \sin(kx + \omega t)$$
 The speed of the wave is:
 - (a) $2\pi k/\omega$
 - (b) ω/k
 - (c) $2\pi/k$
 - (d) $k/2\pi$
10. The heat capacity of object B is twice that of object A. Initially A is at 300 K and B is at 450 K. They are placed in thermal contact and the combination is isolated. The final temperature of both objects is:
 - (a) 200 K
 - (b) 300 K
 - (c) 400 K
 - (d) 450 K
11. An ideal gas expands into a vacuum in a rigid vessel. As a result there is:
 - (a) a change in entropy
 - (b) an increase of pressure
 - (c) a change in temperature
 - (d) a decrease of internal energy
12. A magnetic field exerts a force on a charged particle:
 - (a) always
 - (b) never
 - (c) if the particle is moving across the field lines
 - (d) if the particle is moving along the field lines
13. A point source emits electromagnetic energy at a rate of 100 W. The intensity 10 meters away from the source is:
 - (a) $10W/m^2$
 - (b) $1W/m^2$
 - (c) $0.024W/m^2$

（背面仍有題目，請繼續作答）

(d) 0.080 W/m^2

14. A $5.5 \times 10^{-8} \text{ C}$ charge is fixed at the origin. A $-2.3 \times 10^{-8} \text{ C}$ charge is moved from $x = 3.5 \text{ cm}$ on the x axis to $y = 3.5 \text{ cm}$ on the y axis. The change in the potential energy of the two-charge system is:

(a) $3.2 \times 10^{-4} \text{ J}$
 (b) $-3.2 \times 10^{-4} \text{ J}$
 (c) $9.3 \times 10^{-3} \text{ J}$
 (d) zero

15. A ladder leans against a wall (See FIG. 1). If the ladder is not to slip, which one of the following must be true.

(a) The coefficient of friction between the ladder and the wall must not be zero
 (b) The coefficient of friction between the ladder and the floor must not be zero
 (c) Both (a) and (b)
 (d) Either (a) or (b)

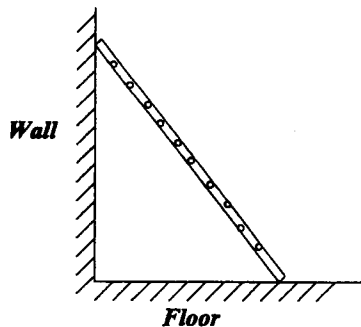


FIG. 1. A ladder leaning against a wall.

16. The formation of ice from water is accompanied by:

(a) absorption of heat
 (b) temperature increase
 (c) decrease in volume
 (d) temperature decrease

17. According to the kinetic theory of gases, the pressure of a gas is due to:

(a) change of kinetic energy of molecules as they strike the wall
 (b) change of momentum of molecules as they strike the wall
 (c) average kinetic energy of the molecules
 (d) force of repulsion between the molecules

18. According to the second law of thermodynamics:

(a) heat cannot be completely converted to work
 (b) work cannot be completely to heat
 (c) for all cyclic processes we have $dQ/T < 0$
 (d) the reason all heat engine efficiencies are less than 100% is friction, which is unavoidable

19. A hollow metal sphere is charged to a potential V . The potential at its center is:

(a) V
 (b) 0
 (c) $-V$
 (d) $2V$

20. Pulling the plates of an isolated charged capacitor apart:

(a) increases the capacitance
 (b) increases the potential difference
 (c) does not affect the potential difference
 (d) does not affect the capacitance

21. A $2\text{-}\Omega$ resistor and a $4\text{-}\Omega$ resistor are connected in parallel to a 6-V battery. The rate of energy dissipated in the $2\text{-}\Omega$ resistor is:

(a) 8 Watts
 (b) 6 Watts
 (c) 9 Watts
 (d) 18 Watts

22. In Ampere's law, $\oint \vec{B} \cdot d\vec{s} = \mu_0 i$, the integration must be over:

(a) any surface
 (b) any closed surface
 (c) any closed path
 (d) any closed path that surrounds all the current producing \vec{B}

23. If the refractive indices of water and glass are $n_{\text{water}} = 1.5$ and $n_{\text{glass}} = 1.33$, then total internal reflection at an interface between this glass and water:

(a) occurs whenever the light goes from glass to water
 (b) occurs whenever the light goes from water to glass
 (c) may occur when the light goes from glass to water
 (d) may occur when the light goes from water to glass

24. In a Young's double-slit experiment, it is essential that the two beams of light:

(a) have exactly equal intensity
 (b) be exactly parallel
 (c) travel equal distances
 (d) come originally from the same source

25. Which of the following electromagnetic radiations has photons with the greatest energy?

(a) blue light
 (b) yellow light
 (c) x-rays
 (d) microwaves

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科目：普通物理

二·簡答題（共十題，每題五分）

1. The position of a particle in circular motion at constant speed may be written as:

$$\vec{r} = r \cos \omega t \hat{i} + r \sin \omega t \hat{j}, \quad \hat{i}^2 = \hat{j}^2 = 1,$$

where $|\vec{r}| = r = \text{constant}$. What is the acceleration \vec{a} of the particle?

2. A box with mass $m = 6.0\text{kg}$ slides with speed $v = 4.0\text{m/s}$ across a frictionless floor in the positive x direction. It suddenly explodes into two pieces: one piece, with mass $m_1 = 2.0\text{kg}$, moves in the positive x direction with speed $v_1 = 8.0\text{m/s}$ (see FIG. 2). Find the velocity v_2 of the second piece with mass m_2 .

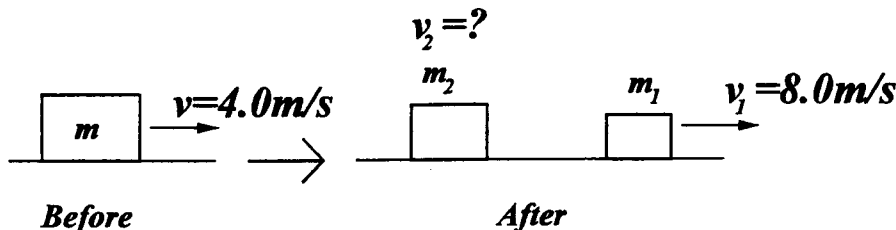


FIG. 2.

3. A fluid of density $\rho = 791\text{kg/m}^3$ flows smoothly through a horizontal pipe that tapers (see FIG. 3) in cross-sectional area from $A_1 = 1.20 \times 10^{-3}\text{m}^2$ to $A_2 = A_1/2$. The pressure difference ΔP between the wide and narrow sections of the pipe is 4120Pa . What is the volume flow rate $R = v_2 A_2$ of the fluid?

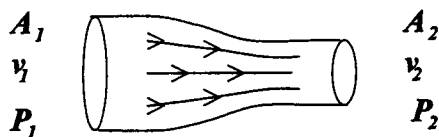


FIG. 3.

4. At $t = 0$, a pulse is described by

$$y(x, t = 0) = \frac{A}{B + x^2}.$$

If it moves in the $+x$ direction at 3m/s , find the function that describes it at time $t = 2\text{s}$.

5. Consider the Carnot cycle (see FIG. 4) operating on ONE mole of ideal gas. The isothermal volume expansion ratio is $V_B/V_A = 2.5$ and the pressure $P_A = 10.0\text{atm} = 1.01 \times 10^4\text{Pa}$. What is the heat transferred Q_1 ? (gas constant $R = 8.314\text{J/mole} \cdot \text{K}$)

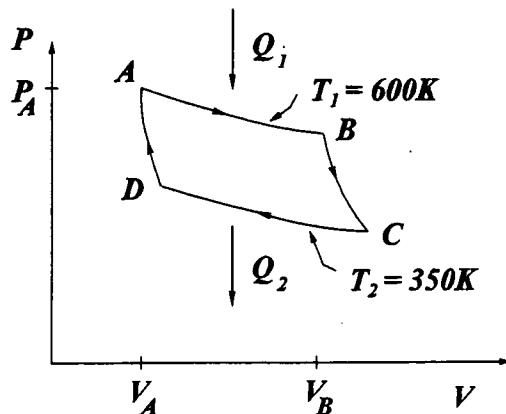


FIG. 4.

(背面仍有題目，請繼續作答)

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6. Consider the distribution of four charges in FIG. 5 Write down the potential $V(x, y)$ at an arbitrary point (x, y) .

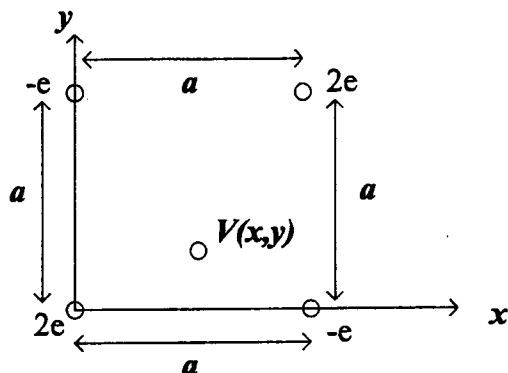


FIG. 5. Potential $V(x, y)$ of a charge distribution.

7. Two charges, one $q_1 = +3\mu C$ and the other $q_2 = +5\mu C$, are ONE meter apart. What is the location of a third charge $q_3 = +2\mu C$ such that it experiences no net force?
8. FIG. 6 shows the discharging of a capacitor C in an RC circuit. Write down the differential equation for the charge $Q(t)$ on the capacitor. (Do not solve the equation.)

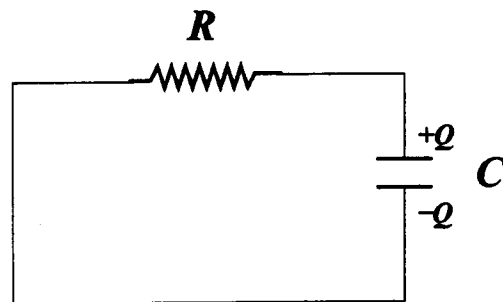


FIG. 6. Discharging of a capacitor in an RC circuit.

9. FIG. 7 shows a wire carrying a current $I = 6.0A$ in the positive direction of the x -axis and lying in a non-uniform magnetic field $\vec{B} = (2.0T/m)x \hat{i} + (2.0T/m)x \hat{j}$ with \vec{B} in teslas and x in meters. Find the force \vec{F}_B on the section of the wire between $x = 0$ and $x = 2.0m$.

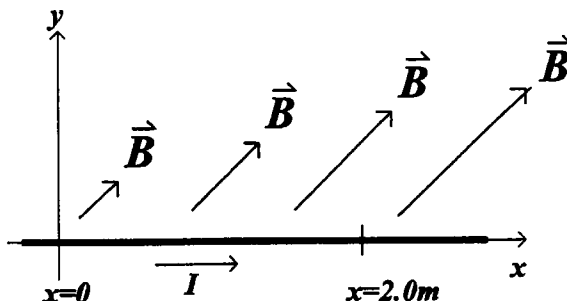


FIG. 7. A wire carrying a current I in the magnetic field \vec{B} .

10. A radio station broadcasts at 89.3 MHz with radiated power of 43 kW. How many photons does it emit each second?

Useful Constants

$$K = \frac{1}{4\pi\epsilon_0} = 9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$$

$$1\mu C = 1 \times 10^{-6} C$$

$$1e = 1.602 \times 10^{-19} C$$

$$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$