

系所組別： 醫學工程研究所丁組

考試科目： 普通物理

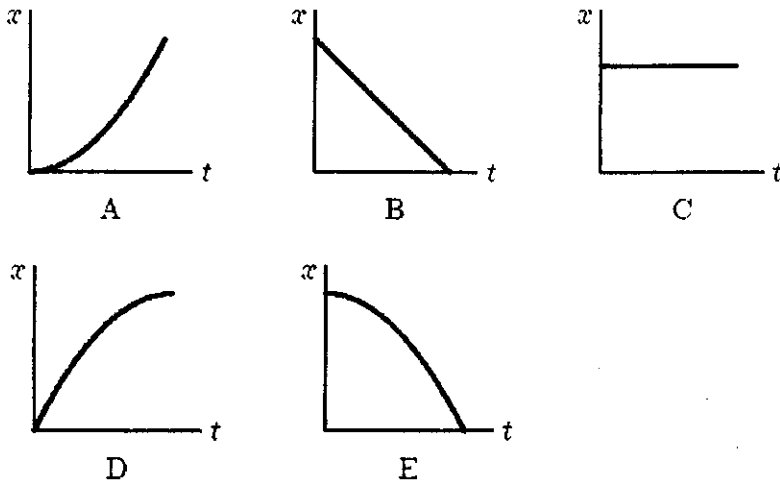
考試日期：0307，節次：1

※ 考生請注意：本試題 可 不可 使用計算機

2009 Biomedical Engineering Master Entrance Exam—Physics (可用計算機)

1. 選擇題 (共60分，每題1.5分，不倒扣)

1. Which of the following five coordinate versus time graphs represents the motion of an object moving with a constant nonzero speed?

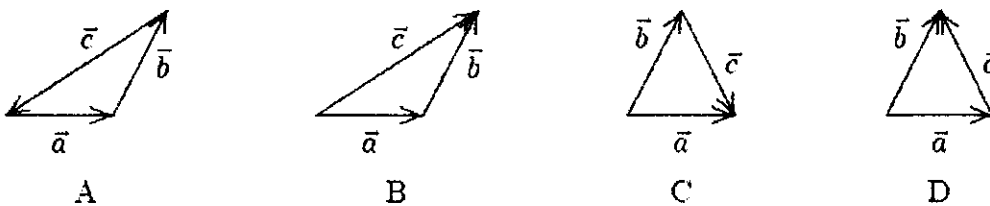


2. The velocity of an object is given as a function of time by $v = 4t - 3t^2$, where v is in m/s and t is in seconds. Its average velocity over the interval from $t = 0$ to $t = 2$ s:

A. is 0 B. is -2m/s C. is 2m/s D. is -4m/s E. cannot be calculated unless the initial position is given

3

The vectors \vec{a} , \vec{b} , and \vec{c} are related by $\vec{c} = \vec{b} - \vec{a}$. Which diagram below illustrates this relationship?



E. None of these

4

If $\vec{A} - \vec{B} = \vec{A} + \vec{B}$ and neither \vec{A} nor \vec{B} vanish, then:

- A. \vec{A} and \vec{B} are parallel and in the same direction
- B. \vec{A} and \vec{B} are parallel and in opposite directions
- C. the angle between \vec{A} and \vec{B} is 45°
- D. the angle between \vec{A} and \vec{B} is 60°
- E. \vec{A} is perpendicular to \vec{B}

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5.

A vector has a magnitude of 12. When its tail is at the origin it lies between the positive x axis and the negative y axis and makes an angle of 30° with the x axis. Its y component is:

- A. $6/\sqrt{3}$
- B. $-6\sqrt{3}$
- C. 6
- D. -6
- E. 12

6.

A vector in the xy plane has a magnitude of 25 m and an x component of 12 m. The angle makes with the positive x axis is:

- A. 26°
- B. 29°
- C. 61°
- D. 64°
- E. 241°

7. A vector has a component of 10m in the $+x$ direction, a component of 10m in the $+y$ direction, and a component of 5m in the $+z$ direction. The magnitude of this vector is:

- A. zero
- B. 15m
- C. 20m
- D. 25m
- E. 225m

8. Which of the following is a scalar quantity?

- A. Speed
- B. Velocity
- C. Displacement
- D. Acceleration
- E. None of these

9. The airplane shown is in level height at an altitude of 0.50 km and a speed of 150 km/h. At what distance d should it release a heavy bomb to hit the target X? Take $g = 10\text{m/s}^2$.

- A. 150m
- B. 295m
- C. 420m
- D. 2550m
- E. 15,000m

10. An object moving at constant velocity in an inertial frame must:

- A. have a net force on it
- B. eventually stop due to gravity
- C. not have any force of gravity on it
- D. have zero net force on it
- E. have no frictional force on it

11. The inertia of a body tends to cause the body to:

- A. speed up
- B. slow down
- C. resist any change in its motion
- D. fall toward Earth
- E. decelerate due to friction

12. The mass of a body:

- A. is slightly different at different places on Earth
- B. is a vector
- C. is independent of the free-fall acceleration
- D. is the same for all bodies of the same volume
- E. can be measured most accurately on a spring scale

13. You stand on a spring scale on the floor of an elevator. Of the following, the scale shows the highest reading when the elevator:

- A. moves upward with increasing speed
- B. moves upward with decreasing speed
- C. remains stationary
- D. moves downward with increasing speed
- E. moves downward at constant speed

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14. A 25-N crate slides down a frictionless incline that is 25° above the horizontal. The magnitude of the normal force of the incline on the crate is:

- A. 11N B. 23N C. 25N D. 100N E. 220N

15. A crane operator lowers a 16,000-N steel ball with a downward acceleration of 3m/s^2 . The tension force of the cable is:

- A. 4900N B. 11,000N C. 16,000N D. 21,000N E. 48,000N

16. A forward horizontal force of 12N is used to pull a 240-N crate at constant velocity across a horizontal floor. The coefficient of friction is:

- A. 0.5 B. 0.05 C. 2 D. 0.2 E. 20

17. A horizontal force of 5.0N pushes a 0.50-kg book against a vertical wall. The book is initially at rest. If the coefficients of friction are $\mu_s = 0.6$ and $\mu_k = 0.80$, the magnitude of the frictional force is:

- A. 0 B. 4.9N C. 3.0N D. 5.0N E. 4.0N

18. Which of the following is the correct combination of dimensions for energy?

- A. MLT B. LT^2/M C. ML^2/T^2 D. $\text{M}^2\text{L}^3\text{T}$ E. ML/T^2

19. The mechanical advantage of any machine is:

- A. the efficiency of the machine
 B. the work done by the machine
 C. the ratio of the work done by the machine to the work expended on it
 D. the ratio of the force exerted by the machine to the force applied to it
 E. the ratio of the force applied to the machine to the force exerted by it

20. A 1-kg block is lifted vertically 1m at constant speed by a boy. The work done by the boy is about:

- A. 1 ft · lb B. 1 J C. 10 J D. 0.1J E. zero

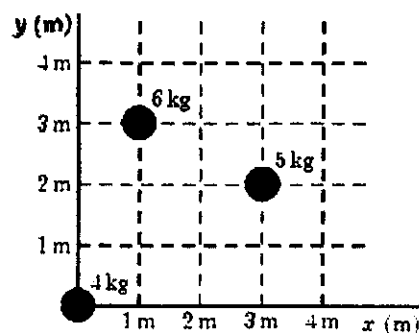
21. No kinetic energy is possessed by:

- A. a shooting star B. a rotating propeller on a moving airplane C. a pendulum at the bottom of its swing D. an elevator standing at the 5th floor E. a cyclone

22. A projectile of mass 0.50 kg is fired with an initial speed of 10m/s at an angle of 60° above the horizontal. The potential energy of the projectile-Earth system when the projectile is at its highest point (relative to the potential energy when the projectile is at ground level) is:

- A. 25 J B. 18.75 J C. 12.5 J D. 6.25 J E. none of these

23. The x and y coordinates of the center of mass of the three-particle system shown below are:



(背面仍有題目,請繼續作答)

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A. 0, 0 B. 1.3m, 1.7m C. 1.4m, 1.9m D. 1.9m, 2.5m E. 1.4m, 2.5m

24. A student's life was saved in an automobile accident because an airbag expanded in front of his head. If the car had not been equipped with an airbag, the windshield would have stopped the motion of his head in a much shorter time. Compared to the windshield, the airbag:

A. causes a much smaller change in momentum B. exerts a much smaller impulse C. causes a much smaller change in kinetic energy D. exerts a much smaller force E. does much more work

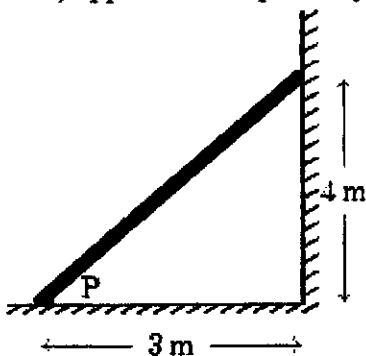
25. The conditions that the net force and the net torque both vanish:

A. hold for every rigid body in equilibrium B. hold only for elastic solid bodies in equilibrium C. hold for every solid body D. are always sufficient to calculate the forces on a solid object in equilibrium E. are sufficient to calculate the forces on a solid object in equilibrium only if the object is elastic

26. The location of which of the following points within an object might depend on the orientation of the object?

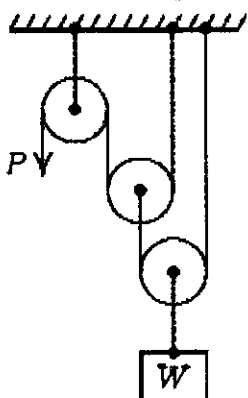
A. Its center of mass B. Its center of gravity C. Its geometrical center D. Its center of momentum E. None of the above

27. An 80-N uniform plank leans against a frictionless wall as shown. The magnitude of the torque (about point P) applied to the plank by the wall is:



A. $40\text{ N} \cdot \text{m}$ B. $60\text{ N} \cdot \text{m}$ C. $120\text{ N} \cdot \text{m}$ D. $160\text{ N} \cdot \text{m}$ E. $240\text{ N} \cdot \text{m}$

28. The ideal mechanical advantage (i.e. the ratio of the weight W to the pull P for equilibrium) of the combination of pulleys shown is:



A. 1 B. 2 C. 3 D. 4 E. 5

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29. The mass of a hypothetical planet is $1=100$ that of Earth and its radius is $1=4$ that of Earth. If a person weighs 600N on Earth, what would he weigh on this planet?
A. 24N B. 48N C. 96N D. 192N E. 600N
30. Gases may be distinguished from other forms of matter by their:
A. lack of color B. small atomic weights C. inability to form free surfaces D. ability to flow
E. ability to exert a buoyant force
31. The magnitude of the charge on an electron is approximately:
A. 10^{23} C B. 10^{-23} C C. 10^{19} C D. 10^{-19} C E. 10^9 C
32. Choose the correct statement concerning electric field lines:
A. field lines may cross B. field lines are close together where the field is large
C. field lines point away from a negatively charged particle D. a charged point particle released from rest moves along a field line E. none of these are correct
33. A cylinder has a radius of 2.1 cm and a length of 8.8 cm. Total charge 6.1×10^{-7} C is distributed uniformly throughout. The volume charge density is:
A. 5.3×10^{-5} C/m³ B. 5.3×10^{-5} C/m² C. 8.5×10^{-4} C/m³ D. 5.0×10^{-3} C/m³ E. 6.3×10^{-2} C/m³
34. Three particles lie on the x axis: particle 1, with a charge of 1×10^{-8} C is at $x = 1$ cm, particle 2, with a charge of 2×10^{-8} C, is at $x = 2$ cm, and particle 3, with a charge of -3×10^{-8} C, is at $x = 3$ cm. The potential energy of this arrangement, relative to the potential energy for infinite separation, is:
A. $+4.9 \times 10^{-4}$ J B. -4.9×10^{-4} J C. $+8.5 \times 10^{-4}$ J D. -8.5×10^{-4} J E. zero
35. A farad is the same as a:
A. J/V B. V/J C. C/V D. V/C E. N/C
36. Two wires made of different materials have the same uniform current density. They carry the same current only if:
A. their lengths are the same B. their cross-sectional areas are the same C. both their lengths and cross-sectional areas are the same D. the potential differences across them are the same E. the electric fields in them are the same
37. For any circuit the number of independent equations containing emf's, resistances, and currents equals:
A. the number of junctions B. the number of junctions minus 1 C. the number of branches D. the number of branches minus 1 E. the number of closed loops
38. 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 E. if the particle is at rest
39. A "coulomb" is:
A. one ampere per second B. the quantity of charge that will exert a force of 1N on a similar charge at a distance of 1m C. the amount of current in each of two long parallel wires, separated by 1m, that produces a force of 2×10^{-7} N/m D. the amount of charge that flows past a point in one second when the current is 1A E. an abbreviation for a certain combination of kilogram, meter and second

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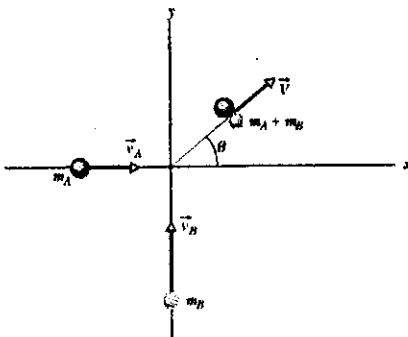
40. Two of Maxwell's equations contain a path integral on the left side and an area integral on the right. For them:

- A. the path must pierce the area B. the path must be well-separated from the area C. the path must be along a field line and the area must be perpendicular to the field line D. the path must be the boundary of the area E. the path must lie in the area, away from its boundary

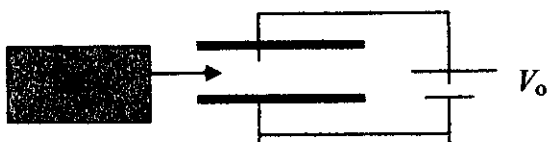
II. 計算題 (40 分，每題10分)

1. (10 Points) A particle of mass $m = 100$ g moves straight forward with an acceleration given by $a(t) = A + Bt^2$, where A and B are constants. (a) If x is in meters and t is in seconds, what are the units of A and B ? (b) If $A = 2$ and $B = 1$ and the particle starts at rest, what are the magnitudes of force and momentum of the particle at $t = 3$ sec?

2. (10 Points) Two skaters collide and embrace, in a completely inelastic collision, as shown below, where the origin is placed at the point of collision. The m_A of 80 kg is originally moving east with speed $v_A = 2$ m/s. The m_B of 50 kg is originally moving north with speed $v_B = 3$ m/s. (a) What is the velocity V of the couple after collision? (b) What is the velocity V_{com} of the center of mass of the two skaters before the collision and after the collision?



3. (10 Points) When a battery of emf V_0 is connected across an empty capacitor of capacitance C_0 , the charge on the plates is Q_0 . A dielectric of dielectric constant κ is inserted between the plates while the battery remains in place. (a) What are the capacitance C and the charge Q on the plates? (b) How much electric energy changes after the dielectric material is inserted?



4. (10 Points) One mole of an ideal gas expands to a final volume of $2V_0$ through an isothermal process. The initial volume and pressure are V_0 and P_0 , respectively.

- (a) Calculate the work W done by the gas through this isothermal process.
 (b) How much heat Q is absorbed by this gas system?
 (c) Determine the change of the internal energy ΔE_{int} for this isothermal process.