※ 注意：

請於答案卷內之「選擇題作答區」作答，未正確填答於「選擇題作答區」不予計分。

選擇題每題4分，請依答案卷首頁所印題號序作答。計算過程可利用答案卷空白處書寫，但不計分。一些常數值：

Speed of light	$c = 3 \times 10^8$ m/s
Electrostatic constant	$k = 9 \times 10^9$ Nm^2/C^2
Electron charge	$e = 1.6 \times 10^{-19}$ C
Boltzmann constant	$k_B = 1.4 \times 10^{-23}$ J/K
Avogadro constant	$N_0 = 6 \times 10^{23}$

1. A child of mass M is swinging on a swing of length L to a maximum deflection angle of θ. A man of mass 4M is swinging on a similar swing of length L to a maximum angle of 2θ. Each swing can be treated as a simple pendulum undergoing simple harmonic oscillation. If the period for the child's motion is T, then the period for the man's motion is
(A) T (B) 2T (C) T/2 (D) T/4.

2. An object is moving in a circular path. If the centripetal force is suddenly removed, how will the object move?
(A) It will move radially outward.
(B) It will move radially inward.
(C) It will move vertically downward.
(D) It will move in the direction in which its velocity vector point at the instant the centripetal force vanishes.

3. A 3.0-kg broom is leaning against a coffee table. A woman lifts the broom handle with her arm fully stretched so that her hand is at a distance of 0.45 m from her shoulder. What torque is produced on her if her arm is at an angle of 50° below the horizontal? (sin50° = 0.766, cos50° = 0.6428)
(A) 7.0 N-m (B) 5.8 N-m (C) 8.5 N-m (D) 10.1 N-m.

4. Two planets have the same radius, R. Each planet has a constant density, but the density of planet 2 is twice as high as that of planet 1. Identical objects of mass m are placed on the surfaces of the planets. What is the relationship of the gravitational potential energy U_1, on planet 1 to U_2 on planet 2?
(A) $U_1 = U_2$ (B) $U_1 = 2U_2$ (C) $U_1 = \frac{1}{2}U_2$ (D) $U_1 = 4U_2$.

5. A disk of clay is rotating with an angular velocity ω along with a blob of clay stuck to the outer rim of the disk. The blob has a mass of $\frac{1}{10}$ of the disk. If the blob detaches and flies off tangent to the outer rim of the disk, what is the angular velocity of the disk after the blob separates?
(A) $\frac{5}{6}\omega$ (B) $\frac{10}{11}\omega$ (C) $\frac{11}{10}\omega$ (D) ω.

6. Consider two carts, of masses m and 2m, at rest on a frictionless air track. If you push the lower-mass cart for 3 s and then the other cart for the same length of time and with the same force, which cart undergoes the larger change in momentum?
(A) The cart with mass m.
(B) The cart with mass 2m.
(C) Same for both carts.
(D) It is not possible to tell from the information given.

7. A block of mass 5.0 kg slides without friction at a speed of 8.0 m/s on a horizontal table surface until it strikes and sticks to a mass of 3.0 kg attached to a horizontal spring (with spring constant k = 1250.0 N-m), which in turn is attached to a wall. How far is the spring compressed before the mass come to rest?
(A) 0.30 m (B) 0.40 m (C) 0.54 m (D) 0.67 m.

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8. An electrical insulator is a material:
(A) containing no electrons.
(B) through which electrons do not flow easily.
(C) that has more electrons than protons on its surface.
(D) that cannot be a pure chemical element.

9. The electric field at a distance of 10 cm from an isolated point particle with a charge of 2×10^{-9} C is:
(A) 1.8 N/C (B) 180 N/C (C) 18 N/C (D) 1800 N/C.

10. A conducting sphere of radius 0.01 m has a charge of 1.0×10^{-9} C deposited on it. The magnitude of the electric field in N/C just outside the surface of the sphere is:
(A) 0 (B) 450 (C) 900 (D) 4500.

11. Eight identical spherical raindrops are each at a potential V, relative to the potential far away. They coalesce to make one spherical raindrop whose potential is:
(A) V/8 (B) V/2 (C) 2V (D) 4V.

12. A farad is the same as a:
(A) J/V (B) V/J (C) C/V (D) V/C.

13. A 10-ohm resistor has a constant current. If 1200 C of charge flow through it in 4 minutes what is the value of the current?
(A) 3.0 A (B) 5.0 A (C) 11 A (D) 15 A.

14. Which of the following statement is not equivalent to the second law of thermodynamics?
(A) It is impossible for a heat engine that operates in a cycle to convert its heat input completely into work.
(B) It is impossible for a cyclical device to transfer heat continuously from a cold body to a hot one without the input of work or other effect on the environment.
(C) The change in the internal energy of the system comes from the heat input minus the work done on its surroundings.
(D) The entropy change of an isolated system always stays constant or increases.

15. A cube that has sides of length L is made of a metal with a coefficient of thermal linear expansion α. What is the approximate ratio of the change in the volume to the original volume as temperature rises by ΔT? (Assume $\alpha\Delta T \ll 1$.)
(A) $3\alpha\Delta T$ (B) $6\alpha\Delta T$ (C) $\alpha^3\Delta T$ (D) $\alpha(1+\alpha)^2\Delta T$.

16. As an n-mole monatomic ideal gas with a volume V expands to 2V at a constant pressure P, what is the heat exchange from the bath to the system?
(A) PV (B) $-$PV (C) $\frac{3}{2}$PV (D) $\frac{5}{2}$PV.

17. A 10-g cube of ice at -10°C is put into a tank of water initially at 4°C with a volume 10 L. Suppose that the specific heat of ice is 2.1 J/gK, and water 4.2 J/gK, and the latent heat of fusion is 334 J/g. What is the approximate entropy change of the cube of ice as it reaches equilibrium with the water in the tank?
(A) 1.3 J/K (B) 13 J/K (C) 65 J/K (D) 130 J/K.

18. Which of the following statement about the Carnot engine is not correct:
(A) The efficiency of a Carnot engine operating between temperatures T_1 and T_2 ($T_1 > T_2$) is $1 - \frac{T_2}{T_1}$.
(B) Carnot engine has the best efficiency for given two heat reservoirs.
(C) The entropy of a Carnot engine during a cycle remains constant.

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(D) The efficiency of any reversible engine is identical to that of a Carnot engine for given two heat reservoirs.

19. The root-mean-square speed of oxygen molecules at 300K is approximately
(A) 0.48 m/s (B) 4.8 m/s (C) 48 m/s (D) 480 m/s.

20. If a light is propagating with plane electromagnetic waves in vacuum, which of the following statements is incorrect?
(A) The electric and magnetic fields are always perpendicular to the traveling direction.
(B) The electric field is always perpendicular to the magnetic field.
(C) The amplitudes of the electric and magnetic fields can be related with a constant, which is the speed of light.
(D) When the amplitude of electric field reaches its maximum, the amplitude of magnetic field reaches its minimum.

21. A system of three polarizing sheets lies in the path of initially unpolarized light, which is in the z direction. The polarizing direction of the first sheet is parallel to the y axis, that of the second sheet is at an angle of 45° from the y axis, and that of the third sheet is parallel to the x axis. What fraction of the initial intensity of the light emerges from the three-sheet system?
(A) 1/2 (B) 1/4 (C) 1/8 (D) 1/16.

22. Consider a classical double-split experiment, which of the following modification of configurations increases the space between bright fringes on the screen?
(A) move the screen toward from the splits;
(B) reduce the distance between the splits;
(C) use a blue light source instead of a red one;
(D) add more splits with the same spacing.

23. Spaceship A and spaceship B are travelling in constant speed but in the opposite direction. The observer on spaceship B has found the length of spaceship A is slightly longer than the length of spaceship B. Afterwards the spaceship B has doubled its speed. Which of the following statements has the chance to be true?
(A) After speed up, the length of spaceship A can be shorter than the length of spaceship B for the same observer on spaceship B.
(B) After speed up, the length of spaceship A can be shorter than the length of spaceship B from another observer on spaceship A.
(C) If spaceship B changed its flight direction to the opposite but with the same speed at the beginning, the length of spaceship A can be shorter than the length of spaceship B from the observer on spaceship A.
(D) If both spaceships are at rest, they can have the same length.

24. A subatomic particle with mass of 3.0 GeV/c^2 has been detected to have a kinetic energy of 2.0 GeV from a ground-based observer. If the lifetime of such particle is 0.1 micro second at its rest frame, how long does it fly measured from the observer?
(A) 24 m (B) 30 m (C) 40 m (D) 50 m.

25. A light of wavelength 30 nm collides with an electron in a Compton's scattering experiment. If 1/3 of the total energy of the light has transferred to the electron, what is the wavelength of the outgoing light?
(A) 15 nm (B) 20 nm (C) 45 nm (D) 60 nm.

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