

※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

一、單選題 (60%，每題 5%，必須標明題號，依序作答；不用寫下推導或計算過程)

1. A particle is trapped by a field with the following potential energy, $U(x) = x^4 - 2x^3 - 5x^2 + 4$
How many stable equilibrium points are there in this field?

- (A) 0 (B) 1 (C) 2 (D) 3 (E) 4

2. A 10-g bullet is fired horizontally into a 10-kg block of wood suspended by a rope from the ceiling. The block swings in an arc, rising 1 cm above its lowest position. Approximately, what is the incident velocity (in unit of m/s) of this bullet?

- (A) 300 (B) 350 (C) 400 (D) 450 (E) 500

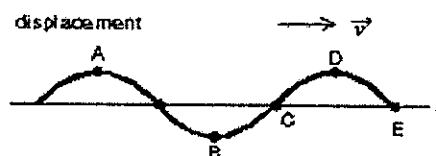
3. A uniform disk with mass m and radius R is rolling down on a 30° inclined plane without slipping. What is the frictional force between the disk and plane? (g : free-fall acceleration)

- (A) 0 (B) $1/6 mg$ (C) $1/3 mg$ (D) $1/2 mg$ (E) $2/3 mg$

4. A large tank filled with water has two small holes in the bottom, one with twice the radius of the other. In steady flow, the speed of water leaving the larger hole is _____ the speed of the water leaving the smaller.

- (A) four times (B) twice (C) half (D) one-fourth (E) the same as

5. A simple harmonic wave is propagating to the $+x$ direction on a string as shown in the right figure. The vertical displacement is actually very small, i.e. not to the scale in this figure. Which of the following statement is correct?



- (A) A has max. kinetic energy (B) B has max. kinetic energy (C) C has max. potential energy
(D) D has max. potential energy (E) E has min. kinetic energy

6. A plane flies at 2 times the sound speed. Its sonic boom reaches a man on the ground ~ 6 sec after the plane passes directly overhead. What is the altitude (in unit of m) of the plane roughly? The sound speed is about 340 m/s.

- (A) 340 (B) 1020 (C) 2040 (D) 2360 (E) 4080

7. A diagnostic ultrasound-echo is reflected from the moving away blood and returns with a frequency 500Hz lower than its original 2.0MHz. The speed (in unit of m/s) of the blood is about? The ultrasound speed is the same as sound speed which is ~ 1600 m/s in blood.

- (A) 0.2 (B) 0.02 (C) 0.002 (D) 0.0002 (E) 0.00002

8. If a black-body has a stable temperature T , it can emit energy via electro-magnetic radiation. This is called black-body radiation and its rate is proportional to?

見背面

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國立臺灣大學115學年度碩士班招生考試試題

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(A) T (B) T^2 (C) T^3 (D) T^4 (E) T^6

9. What is the energy change for a system of n moles of ideal gas in a free expansion process to double its volume? The original system temperature is T and the universal gas const. is R .

(A) 0 (B) $nR \ln 2$ (C) $-nR \ln 2$ (D) $\frac{1}{2} nRT$ (E) nRT

10. If the plate separation of an isolated charged parallel-plate capacitor is doubled:

(A) the electric field is doubled (B) the potential difference is halved
(C) the charge on each plate is halved (D) the system energy keeps the same
(E) none of the above

11. Assuming an electron in a hydrogen atom moves in a circle of radius 1.1×10^{-10} m at a speed 1.6×10^6 m/s, what is the value of magnetic dipole moment (in unit of J/T) of this electron due to its orbital motion?

(A) 2.6×10^{-54} (B) 1.4×10^{-23} (C) 1.9×10^{-23} (D) 2.8×10^{-23} (E) 2.8×10^{-22}

12. The pupil of a person's eye has a diameter of 5.00 mm. What is the proper distance between two small objects such that their images are just resolved when they are 250 mm from the eye and illuminated with light of wavelength 500 nm?

(A) 0.1 cm (B) 0.1 mm (C) 0.01 mm (D) 0.03 cm (E) 0.03 mm

二、簡答題 (40%，每題 10%，要寫下推導過程，以作為給分依據)

13. Assuming no energy dissipation in the following simple harmonic oscillation process, what will be the angular frequency of an oscillating object with mass M connected to a uniform spring of mass m and spring force constant k ?

14. Total charge Q is distributed uniformly throughout a spherical volume of radius R . Find the electric potential V at a distance r from the sphere center assuming $V=0$ at infinity.

15. The current density J inside a long solid cylindrical wire of radius a is in the direction of the central axis. Its magnitude varies linearly with radial distance r from the axis, $J = J_0 r/a$, i.e. $J = 0$ at $r = 0$ and $J = J_0$ at $r = a$. Find the magnetic field in all space.

16. Draw the schematic diagram of the Young's interference experiment. State the important points to carry out such an experiment. Derive an expression for the light intensity I at the detection screen as a function of the deviated angle θ from the central axis, wave length λ and slit spacing d . The maximum intensity is denoted as I_0 at $\theta = 0$.

試題隨卷繳回