

**Physical Constants:**

gravity of Earth:  $g = 9.8 \text{ m/s}^2$

universal gas constant  $R = 8.314 \text{ J/K mol}$

permeability of vacuum:  $\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$

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

1 eV =  $1.60 \times 10^{-19} \text{ J}$

1 Pa =  $1 \text{ N/m}^2$

gravitational constant:  $G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$

velocity of light in vacuum:  $c = 3.00 \times 10^8 \text{ m/s}$

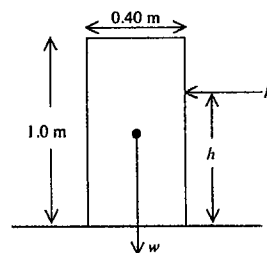
permittivity of vacuum:  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$

electron rest mass:  $m_e = 9.11 \times 10^{-31} \text{ kg}$ .

1 atm =  $10^5 \text{ Pa}$

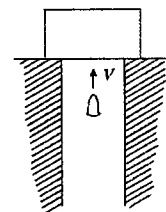
本試題卷共有單選題20題，每題5分。

1. In the figure, a uniform rectangular crate 0.40 m wide and 1.0 m tall rests on a horizontal surface. The crate weighs 1000 N, and its center of gravity is at its geometric center. A horizontal force  $F$  is applied at a distance  $h$  above the floor. If  $h = 0.8 \text{ m}$ , what minimum value of  $F$  is required to make the crate start to tip over? (Static friction is large enough that the crate does not start to slide.)



- (a) 500 N (b) 750 N (c) 250 N (d) 625 N (e) 1000 N
2. A record is dropped vertically onto a freely rotating turntable (kinetic energy of the record is negligible). Frictional forces act to bring the record and turntable to a common angular speed. If the rotational inertia of the record is 0.66 times that of the turntable, what percentage of the initial kinetic energy is lost?
- (a) 40% (b) 34% (c) 56% (d) 66% (e) 19%

3. A 15-g bullet is shot vertically into an 2-kg block. The block lifts upward 8.0 mm (see the figure). The bullet penetrates the block and comes to rest in it in a time interval of 0.0010 s. Assume the force on the bullet is constant during penetration and that air resistance is negligible. The kinetic energy of the bullet lost in the block is closest to
- (a) 14 J (b) 21 J (c) 0.16 J (d) 0.0012 J (e) 10 J



4. A satellite is in circular orbit at an altitude of 2300 km above the surface of a nonrotating asteroid with an orbital speed of 5.9 km/s. The minimum speed needed to escape from the surface of the asteroid is 14.6 km/s. The mass of the asteroid is closest to
- (a)  $3.0 \times 10^{24} \text{ kg}$  (b)  $9.0 \times 10^{23} \text{ kg}$  (c)  $1.0 \times 10^{24} \text{ kg}$  (d)  $2.0 \times 10^{24} \text{ kg}$  (e)  $4.0 \times 10^{24} \text{ kg}$
5. Is it possible for a system to have negative potential energy?
- (a) No, because this would have no physical meaning. (b) No, because the kinetic energy of a system must equal its potential energy. (c) Yes, as long as the kinetic energy is positive. (d) Yes, as long as the total energy is positive. (e) Yes, since the choice of the zero of potential energy is arbitrary.

6. An experimental rocket sits on its launching pad on earth pointing vertically upwards. Its total mass is  $7 \times 10^6 \text{ kg}$ , of which  $6.5 \times 10^6 \text{ kg}$  is fuel. Its engines shoot exhaust downward at a rate of 2000 kg/s with a speed of 3000 m/s relative to the rocket. Calculate the **approximate** delay between ignition and lift off.
- (a) It never lifts off. (b) 53 minutes (c) 27 minutes (d) 1 minutes (e) No delay

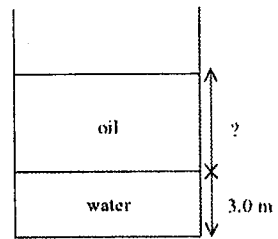
7. A 2.0 kg block on a frictionless table is connected to two ideal massless springs with spring constants  $k_1$  and  $k_2$  whose opposite ends are fixed to walls, as shown in the figure. What is angular frequency of the oscillation if  $k_1 = 7.5 \text{ N/m}$  and  $k_2 = 5.0 \text{ N/m}$ ?



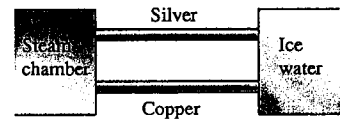
- (a) 2.5 rad/s (b) 3.5 rad/s (c) 0.40 rad/s (d) 0.56 rad/s (e) 1.2 rad/s
8. Upon being struck by 240-nm photons, a metal ejects electrons with a maximum kinetic energy of 1.45 eV. What is the work function of this metal?
- (a) 5.18 eV (b) 4.92 eV (c) 4.33 eV (d) 3.73 eV (e) 3.13 eV

注意：背面有試題

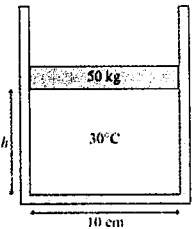
9. In the figure, an open tank contains a layer of oil floating on top of a layer of water (of density  $1000 \text{ kg/m}^3$ ) that is 3.0 m thick, as shown. What must be the thickness of the oil layer if the gauge pressure at the bottom of the tank is to be  $5.0 \times 10^4 \text{ Pa}$ ? The density of the oil is  $510 \text{ kg/m}^3$ .



- (a) 9.2 m (b) 8.2 m (c) 4.1 m (d) 2.0 m (e) 1.2 m
10. Two metal rods, one silver and the other copper, are both attached to a steam chamber as shown in the figure, with a temperature of  $100^\circ\text{C}$ , at one end, and an ice water bath, with a temperature of  $0^\circ\text{C}$ , at the other. The rods are 5.0 cm long and have a square cross-section, 2.0 cm on a side. When steady state has been reached, how much heat flows through the two rods in 1.0 min? The thermal conductivity of silver is  $417 \text{ W/(m}\cdot\text{K)}$ , and that of copper is  $395 \text{ W/(m}\cdot\text{K)}$ . No heat is exchanged between the rods and the surroundings, except at their ends.



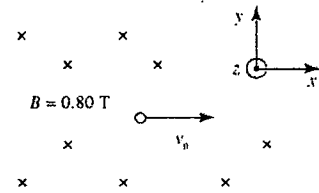
- (a) 20 kJ (b) 11 kJ (c) 49 kJ (d) 47 kJ (e) 39 kJ
11. The figure shows a 50-kg frictionless cylindrical piston that floats on 0.68 mol of compressed air at  $30^\circ\text{C}$ . How far does the piston move if the temperature is increased to  $300^\circ\text{C}$ ?



- (a) 1300 cm (b) 250 cm (c) 130 cm (d) 120 cm (e) 60 cm
12. A solid nonconducting sphere of radius  $R$  carries a charge  $Q$  distributed uniformly throughout its volume. At a certain distance  $r_1$  ( $r_1 < R$ ) from the center of the sphere, the electric field has magnitude  $E$ . If the same charge  $Q$  were distributed uniformly throughout a sphere of radius  $3R$ , the magnitude of the electric field at the same distance  $r_1$  from the center would be equal to
- (a)  $E/9$  (b)  $E/3$  (c)  $3E$  (d)  $9E$  (e)  $E$

13. Each plate of a parallel-plate air-filled capacitor has an area of  $0.0020 \text{ m}^2$ , and the separation of the plates is  $0.020 \text{ mm}$ . An electric field of  $3.9 \times 10^6 \text{ V/m}$  is present between the plates. What is the surface charge density on the plates?
- (a)  $17 \mu\text{C/m}^2$  (b)  $35 \mu\text{C/m}^2$  (c)  $52 \mu\text{C/m}^2$  (d)  $73 \mu\text{C/m}^2$  (e)  $87 \mu\text{C/m}^2$

14. A uniform magnetic field of magnitude  $0.80 \text{ T}$  in the negative  $z$ -direction is present in a region of space, as shown in the figure. A uniform electric field is also present. An electron that is projected with an initial velocity  $v_0 = 9.1 \times 10^4 \text{ m/s}$  in the positive  $x$ -direction passes through the region without deflection. What is the electric field vector in the region? ( $\hat{e}_x$  and  $\hat{e}_y$  are unit vectors in  $x$ - and  $y$ -directions, respectively)



- (a)  $+110 \text{ kV/m } \hat{e}_x$  (b)  $-110 \text{ kV/m } \hat{e}_y$  (c)  $+73 \text{ kV/m } \hat{e}_x$  (d)  $-73 \text{ kV/m } \hat{e}_y$  (e) None of the above.
15. When an  $LRC$  series circuit is at resonance, which one of the following statements about that circuit is accurate?
- (a) The impedance has its maximum value. (b) The reactance of the inductor is zero. (c) The reactance of the capacitor is zero. (d) The reactance due to the inductor and capacitor has its maximum value. (e) The current amplitude is a maximum.

16. A very small source of light that radiates uniformly in all directions produces an electric field amplitude of  $2.96 \text{ V/m}$  at a point  $33.0 \text{ m}$  from the source. What is the average power output from the source?
- (a) 102 W (b) 159 W (c) 256 W (d) 80 W (e) 318 W

注意：背面有試題

國立中央大學101學年度碩士班考試入學試題卷

所別：物理學系碩士班 不分組(一般生) 科目：普通物理 共 3 頁 第 3 頁  
物理學系碩士班 不分組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

17. A capacitor is charging in a simple  $RC$  circuit with a dc battery. Which one of the following statements about this capacitor is accurate?
- (a) There is a magnetic field between the capacitor plates because charge travels between the plates by jumping from one plate to the other. (b) There is no magnetic field between the capacitor plates because no charge travels between the plates. (c) There is a magnetic field between the capacitor plates, even though no charge travels between them, because the electric flux between the plates is changing. (d) There is a magnetic field between the capacitor plates, even though no charge travels between them, because the magnetic flux between the plates is changing. (e) The magnetic field between the capacitor plates is increasing with time because the charge on the plates is increasing.
18. When light goes from one material into another material having a **higher** index of refraction,
- (a) its speed, wavelength, and frequency all decrease. (b) its speed decreases but its frequency and wavelength stay the same. (c) its speed decreases but its wavelength and frequency both increase. (d) its speed increases, its wavelength decreases, and its frequency stays the same. (e) its speed and wavelength decrease, but its frequency stays the same.
19. A energetic particle is moving at  $0.866c$  in a 200 m-long linear particle accelerator. How long does the particle accelerator appear to the particle?
- (a) 100 m (b) 200 m (c) 400 m (d) 173 m (e) 231 m
20. An electron is in an infinite square well (a box) that is  $L = 2.0$  nm wide. The electron makes a transition from the  $n = 8$  to the  $n = 7$  state, what is the wavelength of the emitted photon? (hint: the energy levels for an infinite square well potential is  $E_n = \frac{n^2 h^2}{8m_e L^2}$ )
- (a) 1100 nm (b) 1000 nm (c) 880 nm (d) 750 nm (e) 610 nm