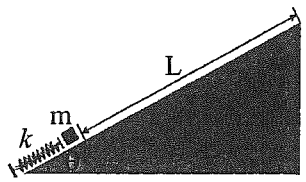
單選題，答案請填於答案卡。一題 5 分，答錯倒扣 1 分，整題不作答不給分也不扣分。 倒扣至本大題(即單選題)0 分為止。

1. A satellite of mass 270 kg is placed into Earth orbit at a height of 1250 km above the surface. Assuming a circular orbit, how long does the satellite take to complete one orbit? ($G = 6.67\times10^{-11}\text{N}\cdot\text{m}^2\cdot\text{kg}^{-2}$, Earth mass = 5.97×10^{24} kg, Earth radius = 6.37×10^{6} m) (A) 5.919×10^{3} s (B) 6.623×10^{3} s (C) 5.278×10^{3} s (D) 7.392×10^{3} s (E) 8.019×10^{3} s

2. A block of mass m is launched up an inclined plane of angle θ = 30° and length L by an ideal spring with constant k as shown in right figure. The coefficient of kinetic friction for the inclined plane is $\mu = 1.0$. What is the minimum compression length of the spring for the mass m to reach L?

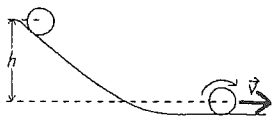


(A) $2.132\sqrt{\frac{mgL}{k}}$ (B) $1.381\sqrt{\frac{mgL}{k}}$ (C) $2.827\sqrt{\frac{mgL}{k}}$ (D) $3.168\sqrt{\frac{mgL}{k}}$ (E) $1.653\sqrt{\frac{mgL}{k}}$

3. Stretching a non-linear spring requires an amount of Work given by the equation $U = 22\,x^2 - 9\,x^3$, where U is in Joules and x is in meters. How much force is required to hold this spring stretched out 4.0m from equilibrium position? (A) 256 N (B) 246 N (C) 278 N (D) 212 N (E) 298 N

4. A diffraction grating having 7000 lines per centimeter is illuminated normally with red light from a helium-neon gas laser. If its second order spectral line is at 62.4°, what is the wavelength of the red laser light?
(A) 650 nm (B) 671 nm (C) 633 nm (D) 648 nm (E) 635 nm

5. A hollow spherical shell of mass M and radius R starts from rest & rolls down without slipping a hill. Its center of mass drops a total distance h. What is the speed of the ball at the bottom of the hill? (A) $\sqrt{\frac{5}{7}gh}$ (B) $\sqrt{3gh}$ (C) $\sqrt{2gh}$ (D) $\sqrt{\frac{6}{5}gh}$ (E) $\sqrt{\frac{10}{7}gh}$



注意:背面有試題

6. A star rotates once every 55 days. It then undergoes supernova explosion, hurling most of its mass into space. The inner core of the star, whose radius is initially 30 Mm, collapses into a neutron star only 8 km in radius. The rotating neutron star emits regular pulses of radio waves, making it a pulsar. What is the pulse rate (= rotation rate)? (Assume core to be a uniform sphere & no external torque.)

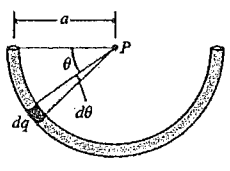
   (A) 1.39×10^5 rev/day (B) 1.78×10^5 rev/day (C) 2.03×10^5 rev/day (D) 2.28×10^5 rev/day (E) 2.56×10^5 rev/day

7. The waves are cosine curve with crests 18 m apart. A vertical distance 4.8 m from trough to crest, which takes 1.7 s. Please describe the wave. (A) $y(x,t) = 4.8cos(0.70x - 3.70t)$ (B) $y(x,t) = 2.4cos(0.35x - 1.85t)$ (C) $y(x,t) = 2.4cos(0.52x - 1.70t)$ (D) $y(x,t) = 4.8cos(0.35x - 1.85t)$ (E) $y(x,t) = 2.4cos(0.28x - 1.32t)$

8. Given average kinetic energy, $\langle K\rangle = \frac{3}{2}kT$, of a molecule in air at room temperature (20°C = 293K), please determine the root-mean-square speed of a O_2 molecule with this energy. ($k = 1.38\times10^{-23}$ J / K, $1u = 1.66\times10^{-27}$ kg) (A) 511 m/s (B) 671 m/s (C) 478 m/s (D) 823 m/s (E) 379 m/s

9. In each of the following processes, does the entropy of the named system decrease? (A) cells differentiate in a growing embryo, forming different organs (B) an animal dies, its remains gradually decays (C) an earthquake demolishes a building (D) a power plant burns coal & produces electrical energy (E) a balloon inflates

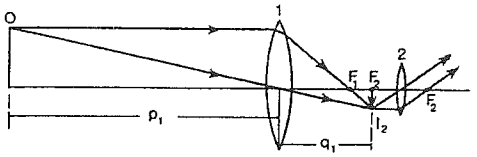
10. A semicircular loop of radius a carries positive charge Q distributed uniformly. What is the magnitude of the electric field at the loop's center (point P in right figure)? (A) $\frac{2kQ}{\pi a}$



(B) $\frac{kQ}{\pi a^2}$ (C) $\frac{kQ}{\pi a}$ (D) $\frac{2kQ}{\pi a^2}$ (E) $\frac{kQ}{2\pi a^2}$

注意:背面有試題

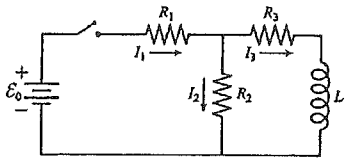
11. An astronomical telescope has an objective of 60-cm focal length as shown in the right figure. The eyepiece has a focal length of 4.5 cm. How far must these lenses be separated when viewing an object 300 cm away from the objective?



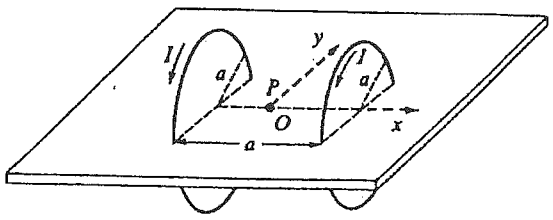
(A) 72.5 cm (B) 76.0 cm (C) 79.5 cm (D) 83.0 cm (E) 86.5 cm

12. A voltmeter reads 110 V when connected across the terminals of a sinusoidal power source with $f = 2000$ Hz. What is the equation for the instantaneous voltage provided by the source? (A) $v = (110\text{V})sin12566t$ (B) $v = (110\text{V})sin6280t$ (C) $v = (156\text{V})sin6280t$ (D) $v = (156\text{V})sin12566t$ (E) $v = (190\text{V})sin12566t$

13. As shown in the right figure, take $\varepsilon_0 = 18$ V, $R_1 = 5\ \Omega$, $R_2 = 10\ \Omega$, and $R_3 = 2.5\ \Omega$. Write the current I_2 immediately after the switch is first closed. (A) 1.2 A (B) 1.5 A (C) 1.8 A (D) 2.1 A (E) 0.0 A

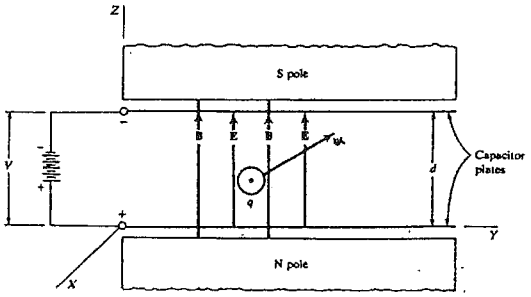


14. Helmholtz coils are sometimes used to obtain a nearly uniform magnetic field in situations where a solenoid would be impractical as shown in the right figure. The magnetic field at the center point on the axis, midway between the coils, how about the derivative of B?



(A) $B(x) \approx B_0 + B'(0)x$ (B) $B(x) \approx B_0 + B''(0)x^2$ (C) $B(x) \approx B_0 + B'''(0)x^3$ (D) $B(x) \approx B_0 + B''''(0)x^4$ (E) $B(x) \approx B_0 + B'''''(0)x^5$

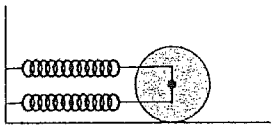
15. A capacitor is placed between the poles of a large magnet, as shown in the right figure. In the space between the plates of the capacitor there is a uniform electric field **E** and also a uniform magnetic field **B**; the two fields are parallel and in the direction of Z. A small sphere, carrying charge $q = 6\,\mu$C, has an instantaneous velocity $\vec{u} = (6\times10^4)(0.766\hat{j} + 0.643\hat{k})$ m/s. If $d = 50$ cm, $V = 3000$ V, and $B = 2.0$ T, what is the instantaneous force on the sphere? (A) $0.552\hat{i} + 0.018\hat{k}$ N (B) $0.643\hat{i} + 0.036\hat{k}$ N (C) $0.766\hat{i} + 0.036\hat{k}$ N (D) $0.766\hat{i} + 0.643\hat{k}$ N (E) $0.552\hat{i} + 0.036\hat{k}$ N



16. A gas mixture contains 4.5 mol of O_2 and 6.0 mol of Ar. What is this mixture's molar specific heat C_V at constant volume? (R = ideal gas constant) (A) 1.7 R (B) 1.9 R (C) 2.1 R (D) 2.3 R (E) 2.5 R

17. A neutron (mass 1.01 u) strikes a deuteron (mass 2.01 u), and they combine to form a tritium nucleus (mass 3.02 u). If the neutron's initial velocity was $34.5\hat{i} + 24.9\hat{j}$ Mm/s and if the tritium leaves the reaction with velocity $21.6\hat{i} + 42.6\hat{j}$ Mm/s, what was the deuteron's velocity? (A) $(10.90\hat{i} + 26.57\hat{j})$ Mm/s (B) $(20.64\hat{i} + 84.26\hat{j})$ Mm/s (C) $(15.12\hat{i} + 51.49\hat{j})$ Mm/s (D) $(41.53\hat{i} + 121.87\hat{j})$ Mm/s (E) $(50.52\hat{i} + 74.89\hat{j})$ Mm/s

18. A solid cylinder of mass m is on a surface as shown in the right figure. It is attached to a wall by two springs with the same constant k. Initially the cylinder is at rest and the springs unstretched. The solid cylinder is pulled a distance A and then released. During the harmonic oscillation, the cylinder is rolling without slipping. What is the speed of the solid cylinder as it passes through equilibrium?



(A) $\sqrt{\frac{4k}{3m}}$A (B) $\sqrt{\frac{10k}{7m}}$A (C) $\sqrt{\frac{6k}{5m}}$A (D) $\sqrt{\frac{k}{m}}$A (E) $\sqrt{\frac{3k}{2m}}$A

注意:背面有試題

19. A cyclic heat engine operates between a source temperature of 900°C and a sink temperature of 20°C. The mechanical work done by this engine is 2 kW. What is the least rate of heat rejection per kW net output of the engine? (A) 0.39 (B) 0.46 (C) 0.53 (D) 0.67 (E) 0.79

20. The switch on the left side of the right figure is closed, allowing current to flow through the coil wrapped around a ferromagnetic torus. Which of the statements below correctly describes what happens just after the switch is closed? (A) There is a clockwise increase in flux in the toroid, and no current flowing through the resistor. (B) There is a clockwise increase in flux in the toroid, and a current flowing through the resistor to the left. (C) There is a clockwise increase in flux in the toroid, and a current flowing through the resistor to the right. (D) There is a counterclockwise increase in flux in the toroid, and a current flowing through the resistor to the left. (E) There is a counterclockwise increase in flux in the toroid, and a current flowing through the resistor to the right.