科目 普通物理 類組別 A3 A6 A7 共 1 頁 第 5 頁

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單選題，每題5分，共20題。

1. A block with mass m is vertically attached between two ideal springs with the force constant k and vertically oscillates (Fig. 1). What is the angular frequency?

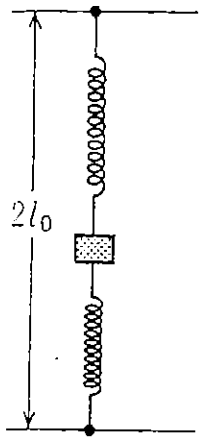


Fig. 1 Problem 1

(a) $\sqrt{m/k}$
(b) $\sqrt{k/m}$
(c) $\sqrt{2m/k}$
(d) $\sqrt{2k/m}$
(e) $2\sqrt{k/m}$

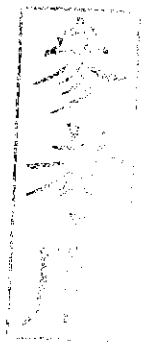
2. Assume that the moon rotates around the earth with radius of 4×10^8 m. What is the orbital period? The gravitational constant $G = 6.67 \times 10^{-11}\text{Nm}^2/\text{kg}^2$, and the earth's mass $M_E = 5.97 \times 10^{24}$ kg.

(a) 2.5×10^4 s
(b) 2.5×10^5 s
(c) 2.5×10^6 s
(d) 2.5×10^7 s
(e) 2.5×10^8 s

3. A pendulum placed on the earth's surface has the period of 1 s. What is the period of this pendulum when placed on the moon surface? The radius and mass of the moon are 3/11 and 1/81 of the earth, respectively.

(a) 0.1 s
(b) 0.4 s
(c) 1 s
(d) 2.5 s
(e) 10 s

4. An apple with mass 0.1 kg falls off from 10 m high to the ground. What is velocity of the apple when it hits the ground (friction is negligible)? The gravitational acceleration on the earth $g = 9.8$ m/s^2.



(a) 14 m/s
(b) 100 m/s
(c) 0.1 m/s
(d) 1 m/s
(e) 10 m/s

5. A boy stands on a board placed on a ice (frictionless). The mass of the boy including the board is 20 kg. When he throws a ball with mass of 1 kg to the right at the speed of 10 m/s (Fig. 2), what is the velocity of the boy and board?

(a) 10 m/s to the left
(b) 10 m/s to the right
(c) 0.5 m/s to the left
(d) 0.5 m/s to the right
(e) 0 m/s

注意:背面有試題

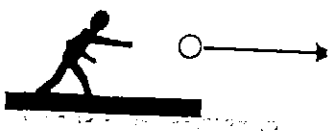


Fig. 2 Problem 5

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6. Two point charges q and $-q$ are fixed at two corners of an equilateral triangle with side of a as shown in Fig. 3. What is the magnitude of electric field at the other corner?

(a) $\frac{q}{4\pi\epsilon_0 a^2}$
(b) $\sqrt{3}\frac{q}{4\pi\epsilon_0 a^2}$
(c) $2\frac{q}{4\pi\epsilon_0 a^2}$
(d) $2\sqrt{3}\frac{q}{4\pi\epsilon_0 a^2}$
(e) 0

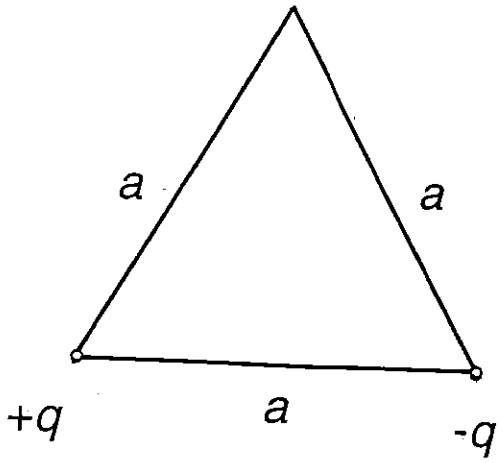

Fig. 3 Problem 6

7. A conducting sphere of radius a has a charge q. It is enclosed by a conducting shell of radius b with a charge $-q$ as shown in Fig. 4. What is the potential difference $V = \phi(a) - \phi(b)$?

(a) $\frac{q}{4\pi\epsilon_0}(\frac{1}{a^2} - \frac{1}{b^2})$
(b) $\frac{-2q}{4\pi\epsilon_0}\frac{1}{b^2}$
(c) 0
(d) $\frac{-2q}{4\pi\epsilon_0}\frac{1}{b}$
(e) $\frac{q}{4\pi\epsilon_0}(\frac{1}{a} - \frac{1}{b})$

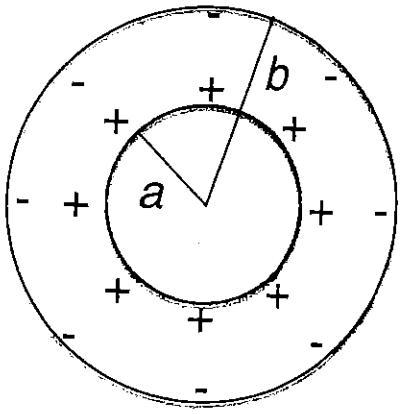

Fig. 4 Problem 7

8. When there is no current through G in Fig. 5, what is the resistance R_4?

(a) $\frac{R_2 R_3}{R_1}$
(b) $\frac{R_3 R_1}{R_2}$
(c) $\frac{R_1 R_2}{R_3}$
(d) $\frac{R_1}{R_2 R_3}$
(e) $\frac{R_2}{R_3 R_1}$

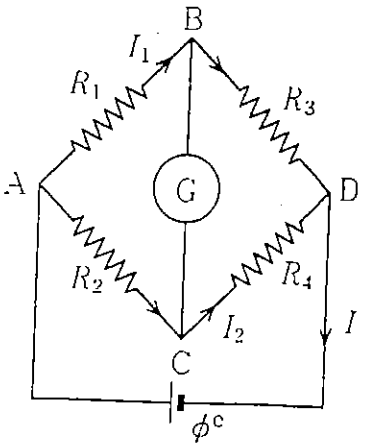

Fig. 5 Problem 8

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9. A very long wire and a loop are in the same plane and carrying current I_1 and I_2 as shown in Fig. 6. Which is the direction of the force on the loop.

(a) Parallel to I_1
(b) Perpendicular to I_1 and repulsive
(c) Perpendicular to I_1 and attractive
(d) Perpendicular to the plane
(e) No force

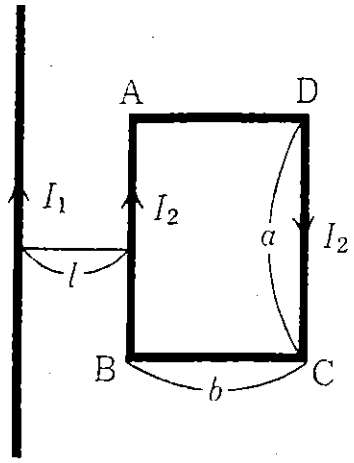

Fig. 6 Problem 9

10. A laser with power of 100 TW ($= 100 \times 10^{12}$ W) is perfectly reflected by a mirror in the normal incidence frame. What is the force exerted on the mirror?

(a) 3.3×10^5 N
(b) 6.7×10^5 N
(c) 3.3×10^6 N
(d) 6.7×10^6 N
(e) No force

11. One kilogram of liquid water at 100° C and 1 atm is vaporized to steam at the same temperature. The latent heat of vaporization of water is 2.3×10^6 J/kg. The steam density at 1 atm is 0.6 kg/m^3, and 1 atm is 1.0×10^5 N/m^2. The volume of liquid water is negligible when compared with that of steam. What is the increase of internal energy?

(a) 2.1×10^6 J
(b) 2.3×10^6 J
(c) 2.5×10^6 J
(d) 4.0×10^6 J
(e) 1.7×10^5 J

12. A Carnot engine operates between 27°C and -23°C. What is the efficiency?

(a) 100 %
(b) 83 %
(c) 54 %
(d) 47 %
(e) 17 %

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13. Figure 7 shows a Carnot cycle in temperature (T) - entropy (S) diagram. Using $TdS = dU + pdV$, where U is internal energy, p is pressure, and V is volume, find the work done in each cycle in the T-S diagram.

(a) a
(b) b
(c) c
(d) d
(e) e

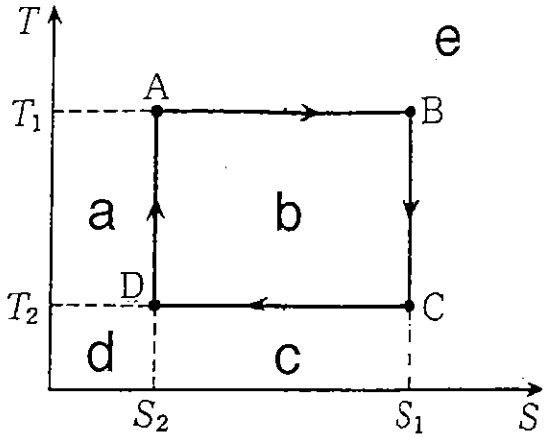

Fig. 7 Problem 13

14. Consider a thermodynamic equilibrium of H_2 and O_2 gases. What is the ratio of the root mean square speeds $\sqrt{\bar{v}^2_{H2}}/\sqrt{\bar{v}^2_{O2}}$?

(a) 1/16
(b) 16
(c) 1
(d) 1/4
(e) 4

15. The work function of sodium is 2.0 eV. A beam with a wavelength of 500 nm ($= 500 \times 10^{-9}$ m) illuminates the surface, what is the maximum kinetic energy of the photoelectrons? Here 1 eV $= 1.6 \times 10^{-19}$ J, the Plank's constant $h = 6.6 \times 10^{-34}$J $\cdot$ s, and the speed of light $c = 3.0 \times 10^8$ m/s.

(a) 1. 0 eV
(b) 4.5 eV
(c) 0.5 eV
(d) 2.5 eV
(e) 2.0 eV

16. X rays of wavelength 0.01 nm ($= 0.01 \times 10^{-9}$ m) are Compton scattered though an angle of 60°. What is the kinetic energy of the scattered electrons, which are initially at rest? Here 1 eV $= 1.6 \times 10^{-19}$ J, the Plank's constant $h = 6.6 \times 10^{-34}$J $\cdot$ s, the speed of light $c = 3.0 \times 10^8$ m/s, and the Compton wavelength $\lambda_c = 2.42 \times 10^{-12}$ m.

(a) 1.3 eV
(b) 1.3×10 eV
(c) 1.3×10^2 eV
(d) 1.3×10^3 eV
(e) 1.3×10^4 eV

注意:背面有試題

17. What is the de Broglie wavelength of an electron with speed of 10^6 m/s? The Plank's constant $h = 6.6 \times 10^{-34}$J $\cdot$ s, and the electron mass $m_e = 9.1 \times 10^{-31}$ kg.

(a) 7.3×10^{-9} m
(b) 7.3×10^{-10} m
(c) 7.3×10^{-11} m
(d) 7.3×10^{-12} m
(e) 7.3×10^{-13} m

18. A rod has a proper length of 1 m in reference frame K'. In reference frame K the rod is half of its proper length. What is the velocity difference between K and K'? Here c is the speed of light.

(a) $c/4$
(b) $c/2$
(c) $3c/4$
(d) $\sqrt{3}c/2$
(e) c

19. A rocket A moves with speed of $c/2$ relative to the earth (E) reference frame. A rocket B moves with $c/2$ relative to A in the same direction. What is the velocity of B relative to E? Here c is the speed of light.

(a) c
(b) $4c/5$
(c) $2c/3$
(d) $c/2$
(e) 0

20. What is the speed of electron with kinetic energy of 1.5 MeV (without including the rest mass energy of $m_e c^2 = 0.5$ MeV)? Here $c = 3.0 \times 10^8$ m/s is the speed of light.

(a) 1.5×10^8m/s
(b) 2.0×10^8m/s
(c) 2.5×10^8m/s
(d) 2.8×10^8m/s
(e) 3.0×10^8m/s