單選題(每題 5 分, 共 100 分)

1-3. A solid uniform disk of mass 21.0kg and radius 85.0cm is at rest flat on a frictionless surface. A string is wrapped around the rim of the disk and a constant force of 30N is applied to the string. The string does not slip on the rim. [I_{COM} for the disk is $1/2MR^2$] When the disk has moved a distance of 9.0m

1. ( )How fast is it moving?

A. 2.6m/s, **B**. 5.1m/s, **C**. 10.3m/s, **D**. 20.4m/s, **E**. None of the above

2. ( )How fast is it spinning ?

A. 3.0 rad/s, **B**. 6.2 rad/s, **C**. 11.9rad/s **D**. 23.5 rad/s, **E**. None of the above

3. ( )How much string (length) has unwrapped from around the rim? (4%)

A. 4.5m, **B**. 9m, **C**.18m, **D**. 36m, **E**. None of the above

4-5. In Fig. 1, a uniform beam of length L is supported by a horizontal cable and a hinge at angle θ. The tension in the cable is T.

4. ( )The gravitational force on the beam is

A. $-2T\cot\theta\,\hat{j}$, **B**. $-2T\sin\theta\,\hat{j}$, **C**. $-2T\cos\theta\,\hat{j}$, **D**. $-2T\tan\theta\,\hat{j}$, **E**. None of the above

5. ( ) The force on the beam from the hinge is

A. $2T\cos\theta\,\hat{i}+T\,\hat{j}$, **B**. $T\sin\theta\,\hat{i}+2T\cot\theta\,\hat{j}$, **C**. $T\cos\theta\,\hat{i}+2T\tan\theta\,\hat{j}$, **D**. $T\,\hat{i}+2T\cot\theta\,\hat{j}$, **E**. None of the above

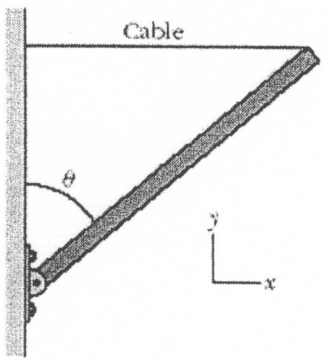

Fig. 1

6-7. Two trains are traveling toward each other at v_t relative to the ground. One train is blowing a whistle at a frequency of f. The speed of sound in air is v.

6. ( ) What frequency is heard on the other train if the wind is blowing at v_w toward the whistle and away from the listener?

A. $f\dfrac{v+v_t-v_w}{v-v_t-v_w}$, **B.** $f\dfrac{v+v_t+v_w}{v-v_t+v_w}$, **C.** $f\dfrac{v-v_t-v_w}{v+v_t+v_w}$, **D.** $f\dfrac{v+v_t+v_w}{v-v_t-v_w}$, **E.** None of the above

7. ( ) What frequency is heard if the wind direction is reversed?

A. $f\dfrac{v+v_t-v_w}{v-v_t-v_w}$, **B.** $f\dfrac{v+v_t+v_w}{v-v_t+v_w}$, **C.** $f\dfrac{v-v_t-v_w}{v+v_t+v_w}$, **D.** $f\dfrac{v+v_t+v_w}{v-v_t-v_w}$, **E.** None of the above

8-9. Fig. 2 shows a stream of water flowing through a hole at depth h in a tank holding water to height H.

8. ( ) At what distance x does the stream strike the floor?

A. $\sqrt{H^2-h^2}$, **B.** $2\sqrt{H^2-h^2}$, **C.** $\sqrt{Hh-h^2}$ **D.** $2\sqrt{Hh-h^2}$, **E.** None of the above

9. ( ) At what depth should a hole be made to maximize x?

A. H, **B.** H/2, **C.** H/4, **D.** H/8, **E.** None of the above

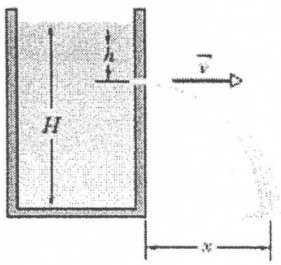

Fig. 2

10-11. A container has a valve that divides it into two parts (A and B), as shown in the figure. The left-hand side (with a volume of V_0) holds an ideal gas at a pressure of $3p_0$, and the right-hand side (with a volume of $4V_0$) holds an ideal gas at a pressure of p_0. Both gases are at room temperature T_0. The valve is opened, and the gases are allowed to mix without reaction.

10. (　) What is the pressure in the container?

A. $4p_0/3$, **B**. $3p_0/4$, **C**. $7p_0/5$, **D**. $5p_0/7$, **E**. None of the above

11. (　) What is the entropy increase of the system ?

A. $\frac{P_0V_0}{T_0}(3\ln 5+4\ln 1.25)$, **B**. $\frac{3P_0V_0}{T_0}(4\ln 5+3\ln 1.25)$, **C**. $\frac{2P_0V_0}{T_0}(3\ln 5+4\ln 1.25)$,

D. $\frac{2P_0V_0}{T_0}(4\ln 5+3\ln 1.25)$, **E**. None of the above

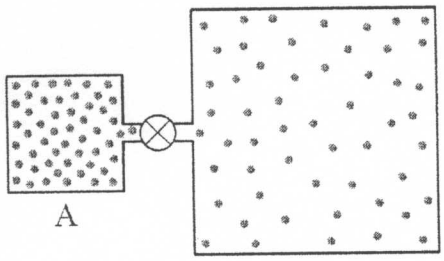

Fig. 3

12-13. A solid nonconducting sphere of radius R has a nonuniform charge distribution of volume charge density $\rho=\rho_s r/R$, where r is radial distance from the sphere's center.

12. (　) What is the sphere's total charge?

A. $2\pi\rho_s R^2$, **B**. $3\pi\rho_s R$, **C**. $\pi\rho_s R^2$ **D**. $\pi\rho_s R^3$, **E**. None of the above

13. (　)What is the magnitude E of the electric field at $r=R/2$?

A. $\frac{\rho_s R}{4\varepsilon_0}$, **B**. $\frac{\rho_s R}{8\varepsilon_0}$, **C**. $\frac{\rho_s R}{16\varepsilon_0}$, **D**. $\frac{\rho_s R}{32\varepsilon_0}$, **E**. None of the above

14. ( ). Figure 4 shows, in cross section, two solid spheres with uniformly distributed charge throughout their volumes. Each has radius R. Point P lies on a line connecting the centers of the spheres, at radial distance $R/2.00$ from the center of sphere 1. If the net electric field at point P is zero, what is the ratio q_2/q_1 of the total charge q_2 in sphere 2 to the total charge q_1 in sphere 1?

A. 9/8, **B**. 2/3, **C**. 7/5, **D**. 11/6, **E**. None of the above

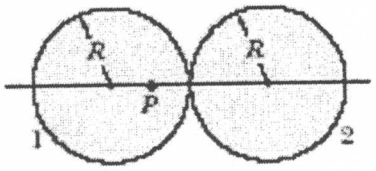

Fig. 4

15. ( ) Figure 5 shows a cross section of a long thin ribbon of width w that is carrying a uniformly distributed total current i into the page.
What is the magnetic field **B** at a point P in the plane of the ribbon at a distance d from its edge?

A. $\frac{\mu_0 i}{2\pi w}\ln\left(\frac{w}{d}\right)$, **B**. $\frac{\mu_0 i}{2\pi w}\ln\left(1+\frac{w}{d}\right)$, **C**. $\frac{\mu_0 i}{\pi w}\ln\left(2+\frac{w}{d}\right)$, **D**. $\frac{\mu_0 i}{\pi w}\ln\left(1+\frac{w}{d}\right)$, **E**. None of the above

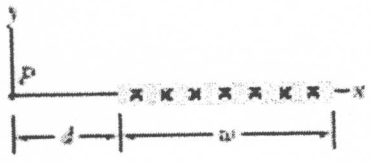

Fig. 5

16-17. In Fig. 6, after switch S is closed at time t =0, the emf of the source is automatically adjusted to maintain a constant current i.

16. ( ) The current through the inductor at time t is:

A. $ie^{-Rt/L}$, **B.** $i(1-e^{-Rt/2L})$, **C.** $ie^{-Rt/2L}$, **D.** $i(1-e^{-Rt/L})$, **E.** None of the above

17. ( ) At what time is the current through the resistor equal to the current through the inductor? t=

A. 2Lln2/3R, **B.** Lln2/3R, **C.** Lln2/R, **D.** 2Lln2/R, **E.** None of the above

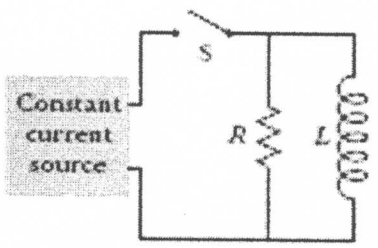

Fig. 6

18. ( ) In an x-ray diffraction measurement, if first-order reflection occurs in a crystal at Bragg angle θ_1, at what Bragg angle θ_2 does second-order reflection occur from the same family of reflecting planes? θ_2=

A. $2\theta_1$, **B.** $2\sin\theta_1$, **C.** $\sin^{-1}(2\theta_1)$, **D.** $\sin^{-1}(2\sin\theta_1)$, **E.** None of the above

19-20. An electron and a photon each have a wavelength of λ. h is the Planck constant and m_e is the mass of electron.

19. ( ) What is the energy of the electron?

A. $h^2/2m_e\lambda^2$, **B.** $h/2m_e\lambda$, **C.** $h^2/m_e\lambda^2$, **D.** $h/m_e\lambda$, **E.** None of the above

20. ( ) What is the energy of the photon?

A. $c/h\lambda$, **B.** hc/λ, **C.** $h\lambda/c$, **D.** λ/hc, **E.** None of the above