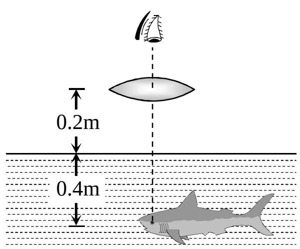
PRACTICE SET -2

1. A short linear object of length l lies along the axis of a concave mirror of focal length f at a distance u from the pole of the mirror. The size of the image is approximately equal to

a. $l\left(\frac{u-f}{f}\right)^{1/2}$ b. $l\left(\frac{u-f}{f}\right)^{2}$

c. $l\left(\frac{f}{u-f}\right)^{1/2}$ d. $l\left(\frac{f}{u-f}\right)^{2}$

2. A small fish 0.4 m below the surface of a lake is viewed through a simple converging lens of focal length 3 m. The lens is kept at 0.2 m above the water surface such that fish lies on the optical axis of the lens. The image of the fish seen by observer will be at $\left(\mu_{water} = \frac{4}{3}\right)$:



a. A distance of 0.2 m from the water surface
b. A distance of 0.6 m from the water surface
c. A distance of 0.3 m from the water surface
d. The same location of fish

3. Light of wavelength 6000 12×10^{-6}m is incident on a single slit. First minimum is obtained at a distance of 0.4 cm from the centre. If width of the slit is 0.3 mm, then distance between slit and screen will be:

a. 1.0 m b. 1.5 m c. 2.0 m d. 2.3 m

4. A plane electromagnetic wave of frequency w_0 falls normally on the surface of a mirror approaching with a relativistic velocity v. Then frequency of the reflected wave will be $\left(\text{given } \beta = \frac{v}{c}\right)$:

a. $\left(\frac{1-\beta}{1+\beta}\right)w_0$ b. $\frac{1+\beta}{(1-\beta)w_0}$

c. $\frac{(1+\beta)w_0}{(1-\beta)}$ d. $\frac{(1-\beta)}{(1+\beta)w_0}$

5. In the above question wavelength is

a. 666 nm b. 666 Å

c. 666 μm d. 6.66 nm0

6. In above question, the coherence time will be

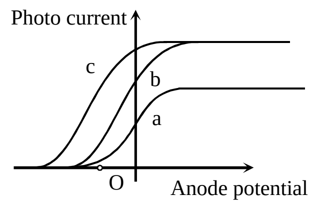
a. 8×10^{-11}s b. 8×10^{-10}s

c. 8×10^{-9}s d. 8×10^{-8}s

7. Which of the following statement is not correct?

a. Photographic plates are sensitive to infrared rays
b. Photographic plates are sensitive to ultraviolet rays
c. Infrared rays are invisible but can cast shadows like visible light
d. Infrared photons have more energy than photons of visible light

8. The figure shows the variation of photocurrent with anode potential for a photo-sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively.



a. $f_a = f_b$ and $I_a \neq I_b$ b. $f_a = f_c$ and $I_a = I_c$

c. $f_a = f_b$ and $I_a = I_b$ d. $f_a = f_b$ and $I_a = I_b$

9. The ratio of specific charge e/m of an electron to that of a Hydrogen ion is

a. 1 : 1 b. 1840 : 1

c. 1 : 1840 d. 2 : 1

10. The energy required to excite an electron from the ground state of hydrogen atom to the first excited state, is:

a. 1.602×10^{-14} J b. 1.619×10^{-16} J

c. 1.632×10^{-18} J d. 1.656×10^{-20} J

11. A nucleus $_ZX^A$ emits 9α-particles and 5p particle. The ratio of total protons and neutrons in the final nucleus is:

a. $\frac{Z-13}{(A-Z-23)}$ b. $\frac{(Z-18)}{(A-36)}$

c. $\frac{(Z-13)}{(A-36)}$ d. $\frac{(Z-13)}{(A-Z-13)}$

12. 1 mg gold undergoes decay with 2.7 days half-life period, amount left after 8.1 days is:

a. 0.91 mg b. 0.25 mg

c. 0.5 mg d. 0.125 mg

13. In a radio receiver, the short wave and medium wave stations are tuned by using the same capacitor but coils of different inductance L_s and L_m respectively then

a. $L_s > L_m$ **b.** $L_s < L_m$

c. $L_s = L_m$ **d.** None of these

14. An antenna current of an AM broadcast transmitter modulated by 50% is 11 *A*. The carrier current is:

a. 10.35 *A* **b.** 9.25 *A* **c.** 10 *A* **d.** 5.5 *A*

15. The unit of specific resistance:

a. Ohm/cm^2 **b.** Ohm/cm

c. $Ohm-cm$ **d.** $(Ohm-cm)^{-1}$

16. One yard in SI units is equal:

a. 1.9144 meter **b.** 0.9144 meter

c. 0.09144 kilometer **d.** 1.0936 kilometer

17. If the three points with position vectors (1, a, b) ; (a, 2, b) and (a, b, 3) are collinear in space, then the value of a + b is:

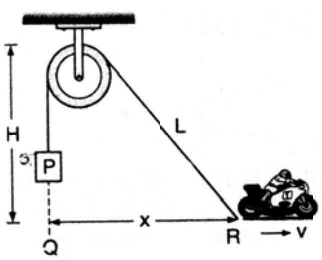
a. 3 **b.** 4 **c.** 5 **d.** none

18. The unit vector along $\hat{i}+\hat{j}$ is:

a. $\hat{k}$ **b.** $\hat{i}+\hat{j}$

c. $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ **d.** $\frac{\hat{i}+\hat{j}}{2}$

19. If the velocity of the motorcycle *v* is constant, then determine the velocity of the mass as a function of *x*. Given that ends *P* and *R* are co-incident on *Q* when *x* = 0:



a. $\frac{xv}{\sqrt{H^2+x^2}}$ **b.** $\frac{H^2+x^2}{xv}$

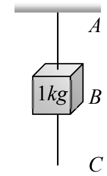
c. $\sqrt{\frac{H^2+x^2}{xv}}$ **d.** $\frac{H^2+x^2}{(xv)^2}$

20. *A* body is thrown vertically upwards form the top *A* of tower. It reaches the ground in t_1 second. If it is thrown vertically downwards form *A* with the same speed it reaches the ground in t_2 second. If it is allowed to fall freely form *A*, then the time it takes to reach the ground is given by:

a. $t=\frac{t_1+t_2}{2}$ **b.** $t=\frac{t_1-t_2}{2}$

c. $t=\sqrt{t_1 t_2}$ **d.** $t=\sqrt{\frac{t_1}{t_2}}$

21. *A* mass of 1 *kg* is suspended by a string *A*. Another string *C* is connected to its lower end (see figure). If a sudden jerk is given to C, then



a. The portion *AB* of the string will break

b. The portion *BC* of the string will break

c. None of the strings will break

d. The mass will start rotating

22. *A* body of mass 2 *kg* has an initial velocity of 3 *metres* per second along *OE* and it is subjected to a force of 4 *N* in a direction perpendicular to *OE*. The distance of the body from *O* after 4 seconds will be:

a. 12 *m* **b.** 20 *m* **c.** 8 *m* **d.** 48 *m*

23. *A* force acts on a 30 *gm* particle in such a way that the position of the particle as a function of time is given by $x=3t-4t^2+t^3$, where *x* is in *metres* and *t* is in seconds. The work done during the first 4 seconds is:

a. 5.28 *J* **b.** 450 *mJ* **c.** 490 *mJ* **d.** 530 *mJ*

24. *A* uniform chain of length 2 *m* is kept on a table such that a length of 60 *cm* hangs freely from the edge of the table. The total mass of the chain is 4 *kg*. What is the work done in pulling the entire chain on the table?

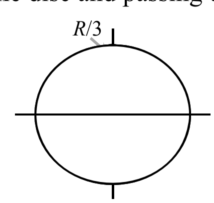
a. 7.2 *J* **b.** 3.6 *J*

c. 120 *J* **d.** 1200 *J*

25. The moment of inertia of a ring about one of its diameters is *I*. What will be its moment of inertia about a tangent parallel to the diameter?

a. $4I$ **b.** $2I$ **c.** $\frac{3}{2}I$ **d.** $3I$

26. From a circular disc of radius *R* and mass 9*M*, a small disc of radius *R*/3 is removed from the disc. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through *O* is:



a. $4MR^2$ **b.** $\frac{40}{9}MR^2$

c. $10MR^2$ **d.** $\frac{37}{9}MR^2$

27. The displacement of a particle moving in S.H.M. at any instant is given by $y = a\sin\omega t$. The acceleration after time $t = \frac{T}{4}$ is (where, T is the time period):

a. $a\omega$ **b.** $-a\omega$ **c.** $a\omega^2$ **d.** $-a\omega^2$

28. The motion of a particle executing S.H.M. is given by $x = 0.01\sin 100\pi(t + .05)$, where x is in metres and time is in seconds. The time period is:

a. 0.01 sec **b.** 0.02 sec
c. 0.1 sec **b.** 0.2 sec

29. Two planets revolve round the sun with frequencies N_1 and N_2 revolutions per year. If their average orbital radii be R_1 and R_2 respectively, then R_1 / R_2 is equal to:

a. $(N_1/N_2)^{3/2}$ **b.** $(N_2/N_1)^{3/2}$
c. $(N_1/N_2)^{2/3}$ **d.** $(N_2/N_1)^{2/3}$

30. Acceleration due to gravity on moon is 1/6 of the acceleration due to gravity on earth. If the ratio of densities of earth (ρ_e) and moon (ρ_m) is $\left(\frac{\rho_e}{\rho_m}\right) = \frac{5}{3}$ then radius of moon R_m in terms of R_e will be:

a. $\frac{5}{18}R_e$ **b.** $\frac{1}{6}R_e$
c. $\frac{3}{18}R_e$ **d.** $\frac{1}{2\sqrt{3}}R_e$

31. *A* cylinder is filled with liquid of density up to a height *h*. if the beaker is at rest the mean pressure at than walls is:

a. 0 **b.** hdg **c.** $hdg/2$ **d.** $2hdg$

32. *A* common hydrometer has a uniform stem graduated downwards form 0, 1, 2,.. up to 10. When floating in pure water it reads 0 and in a liquid of relative density 1.5 it reads 10. What is the relative density of liquid in which it reads 5?

a. 1.15 **b.** 1.20
c. 1.25 **d.** 1.30

33. Steel and copper wires of same length are stretched by the same weight one after the other. Young's modulus of steel and copper are $2\times10^{11} N/m^2$ and $1.2\times10^{11} N/m^2$. The ratio of increase in length.

a. $\frac{2}{5}$ **b.** $\frac{3}{5}$
c. $\frac{5}{4}$ **d.** $\frac{5}{2}$

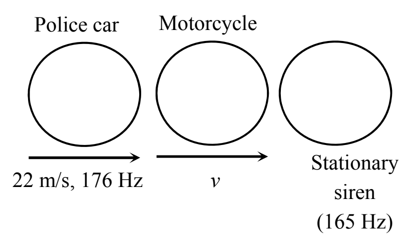
34. *A* rod is fixed between two points at 20°*C*. The coefficient of linear expansion of material of rod is $1.1\times10^{-5}/°C$ and Young's modulus is $1.2\times10^{11} N/m$. Find the stress developed in the rod if temperature of rod becomes 10°*C*

a. $1.32\times10^7 N/m^2$ **b.** $1.10\times10^{15} N/m^2$
c. $1.32\times10^8 N/m^2$ **d.** $1.10\times10^6 N/m^2$

35. *A* transverse wave is described by the equation $y = y_0 \sin 2\pi\left(ft - \frac{x}{\lambda}\right)$. The maximum particle velocity is equal to four times the wave velocity if:

a. $\lambda = \pi y_0/4$ **b.** $\lambda = \pi y_0/2$
c. $\lambda = \pi y_0$ **d.** $\lambda = 2\pi y_0$

36. *A* police car moving at 22 m/s chases a motorcyclist. The police man sounds his horn at 176 Hz, while both of them move towards a stationary siren of frequency 165 Hz. Calculate the speed of the motorcycle. If it is given that the motorcyclist does not observe any beats: (speed of sound = 330 m/s)



a. 33 m/s **b.** 22 m/s
c. zero **d.** 11 m/s

37. *A* pendulum clock keeps correct time at 0°*C*. Its mean coefficient of linear expansions is $\alpha/°C$, then the loss in seconds per day by the clock if the temperature rises by $t°C$ is:

a. $\dfrac{\frac{1}{2}\alpha t\times864000}{1-\frac{\alpha t}{2}}$ **b.** $\frac{1}{2}\alpha t\times86400$

c. $\dfrac{\frac{1}{2}\alpha t\times86400}{\left(1-\frac{\alpha t}{2}\right)^2}$ **d.** $\dfrac{\frac{1}{2}\alpha t\times86400}{1+\frac{\alpha t}{2}}$

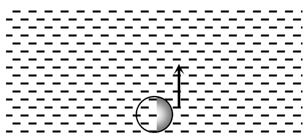
38. *A* beaker is completely filled with water at 4°*C*. It will overflow if:

a. Heated above 4°*C*
b. Cooled below 4°*C*
c. Both heated and cooled above and below 4°*C* respectively
d. None of the above

39. One mole of a monatomic ideal gas is mixed with one mole of a diatomic ideal gas. The molar specific heat of the mixture at constant volume is:

a. 8 **b.** $\frac{9R}{4}$ **c.** $2R$ **d.** 2.5 R

40. An air bubble doubles its radius on raising from the bottom of water reservoir to be the surface of water in it. If the atmospheric pressure is equal to 10 m of water, the height of water in the reservoir is:



a. 10 m **b.** 20 m **c.** 70 m **d.** 80 m

41. The displacement equation of a particle is $x = 3\sin 2t + 4\cos 2t$. The amplitude and maximum velocity will be respectively:

a. 5, 10 **b.** 3, 2
c. 4, 2 **d.** 3, 4

42. 2 kg of ice at -20°C is mixed with 5 kg of water at 20°C in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water and ice are 1 kcal/kg/°C and 0.5 kcal/kg/°C while, the latent heat of fusion of ice is 80 kcal/kg.

a. 7 kg **b.** 6 kg
c. 4 kg **d.** 2 kg

43. If the radius and length of a copper rod are both doubled, the rate of flow of heat along the rod increases:

a. 4 times **b.** 2 times
c. 8 times **d.** 16 times

44. The lengths and radii of two rods made of same material are in the ratios 1 : 2 and 2 : 3 respectively. If the temperature difference between the ends for the two rods be the same, then in the steady state, the amount of heat flowing per second through them will be in the ratio:

a. 1: 3 **b.** 4 : 3
c. 8 : 9 **d.** 3 : 2

45. The maximum energy in the thermal radiation from a hot source occurs at a wavelength of 11×10^{-5}cm. According to Wien's law, the temperature of the source (on Kelvin scale) will be n times the temperature of another source (on Kelvin scale) for which the wavelength at maximum energy is 5.5×10^{-5}cm. The value of n is:

a. 2 **b.** 4 **c.** $\frac{1}{2}$ **d.** 1

46. Air is expand from 50 litres to 150 litres at atmospheric pressure. The external work done is
(Given, 1 atm = 10^5 Nm^{-2})

a. 2×10^{-8} J b. 2×10^4
c. 200 J d. 2000 J

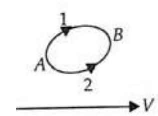
47. An electric heater supplies heat to a system at a rate of 120 W. If system performs work at a rate of 80 J s^{-1}, the rate of increase in internal energy is

a. 30 J s^{-1} **b.** 40 J s^{-1}
c. 50 J s^{-1} d. 60 J s^{-1}

48. 1 kg of water is heated from 40°C to 70°C, If its volume remains constant, then the change in internal energy is (specific heat of water = 4148 J $kg^{-1}K^{-1}$)

a. 2.44×10^5 J b. 1.62×10^5 J
c. 1.24×10^5 J d. 2.62×10^5 J

49. A system goes from A to B by two different paths in the P-V diagram as shown in figure. Heat given to the system in path P 1 is 1100 J, the work done by the system along path 1 is more than path 2 by 150 J. The heat exchanged by the system in path 2 is



a. 800 J **b.** 750 J
c. 1050 J **d.** 950 J

50. A geyser heats water flowing at the rate of 4 litre per minute from 30 °C to 85 °C. If the geyser operates on a gas burner then the amount of heat used per minute is

a. 9.24×10^5 J **b.** 6.24×10^7 J
c. 9.24×10^7 J **d.** 6.24×10^5 J

Answers and Solutions

1. **(d)** From mirror formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ . . . (i)

Differentiating equation (i), we obtain

$$0 = -\frac{1}{v^2}dv - \frac{1}{u^2}du$$

$$\Rightarrow \quad dv = -\left(\frac{v}{u}\right)^2 du \quad . . . (ii)$$

Also from equation (i) $\frac{v}{u} = \frac{f}{u-f}$ . . . (iii)

From equation (ii) and (iii)

we get $dv = -\left(\frac{f}{u-f}\right)^2 . l$

Therefore, size of image is $\left(\frac{f}{u-f}\right)^2 l.$

2. **(d)** Apparent distance of fish from lens

$$u = 0.2 + \frac{h}{\mu} = 0.2 + \frac{0.4}{4/3} = 0.5m$$

From $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

$$\Rightarrow \frac{1}{(+3)}=\frac{1}{v}-\frac{1}{(-0.5)}$$

$v=-0.6\,\text{m}$

The image of the fish is still where the fish is 0.4 m below the water surface.

3. **(c)** Using a sin θ = nλ

or $a.\frac{x}{D}=n\lambda$ or $a=n\lambda.\frac{D}{x}$

or $D=\frac{a.x}{n\lambda}$

$$\Rightarrow \frac{3\times10^{-4}\times4\times10^{-3}}{1\times6000\times10^{-10}}m=2.0\text{m}$$

4. **(c)** Frequency of E_m waves going towards the approaching mirror, $w'=\frac{c+\upsilon}{c}.w_0$

Frequency of waves reflected from mirror and movi9ng towards source, $w''=\frac{c}{c-\upsilon}.w'$

or $w''=\frac{c}{c-\upsilon}x\frac{c+\upsilon}{c}.w_0=\left(\frac{c+\upsilon}{c-\upsilon}\right)w_0$

$$w''=\frac{c\left(1+\frac{\upsilon}{c}\right)}{c\left(1-\frac{\upsilon}{c}\right)}w_0$$

$$\Rightarrow \frac{\left(1+\frac{\upsilon}{c}\right)}{\left(1-\frac{\upsilon}{c}\right)}w_0=\left(\frac{1+\beta}{1-\beta}\right)w_0 \text{ where } \beta=\frac{\upsilon}{c}$$

5. **(a)** Here; $\frac{2\pi}{\lambda}=3\times10^6\pi$.

or $\lambda=\frac{2}{3\times10^6}=0.666\times10^{-6}=666\times10^{-9}\,\text{m}$.

6. **(a)** The coherence time, $t=\frac{l}{c}=\frac{0.024}{3\times10^8}=8\times10^{-11}\text{s}$.

7. **(d)** $E\propto\frac{1}{\lambda}$; also $\lambda_{\text{infrared}}>\lambda_{\text{visible}}$ so $E_{\text{infrared}}<E_{\text{visible}}$

8. **(a)** The stopping potential for curves a and b is same.

$\therefore$ $f_a=f_b$

Also saturation current is proportional to intensity

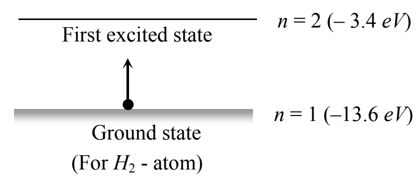
$\therefore$ $I_a<I_b$

9. **(b)** $\frac{(e/m)_{electron}}{(e/m)_{Hydrogen}}=\frac{M_{Hydrogen}}{M_{electron}}=\frac{1840}{1}$

10. **(c)** Energy to excite the e^- from $n=1$ to $n=2$

$E=-3.4-(-13.6)=10.2\,eV=10.2\times1.6\times10^{-19}$

$=1.632\times10^{-18}\,J$



11. **(a)** ${}_ZX^A \xrightarrow{9\alpha,} {}_{Z-18}X^{A-36} \xrightarrow{5\beta} {}_{Z-13}X^{A-36}$

Number of protons = (Z = 13)

Number of neutrons = (A – 36) – (Z – 13) = (A – Z – 23)

$\therefore$ $\frac{P}{N}=\frac{(Z-13)}{(A-Z-23)}$

12. **(d)** $N=N_0\left(\frac{1}{2}\right)^n \Rightarrow N=N_0\left(\frac{1}{2}\right)^{t/T_{1/2}}$

$$\Rightarrow N=1\times\left(\frac{1}{2}\right)^{\frac{8.1}{2.7}}=\left(\frac{1}{2}\right)^3=\frac{1}{8}$$

$$\Rightarrow N=\frac{1}{8}mg=0.125\,mg$$

13. **(b)** As $\nu=\frac{c}{\lambda}$

$\Rightarrow \nu_m=\frac{c}{\lambda_m}$ and $\nu_s=\frac{c}{\lambda_s}$

$\Rightarrow$ $\lambda_m>\lambda_s$

$\Rightarrow$ $\nu_m<\nu_s$

Also $\nu_m=\frac{1}{2\pi\sqrt{L_mC}}$

and $\nu_s=\frac{1}{2\pi\sqrt{L_sC}}$

$$\Rightarrow \frac{\nu_m}{\nu_s}=\sqrt{\frac{L_s}{L_m}}$$

$\Rightarrow$ $L_s<L_m$.

14. **(a)** $I_{Carrier}=\frac{I_{rms}}{\sqrt{1+\frac{m_a^2}{2}}}=\frac{11}{\sqrt{1+\frac{(0.5)^2}{2}}}=10.35\,A$

15. **(c)** $R=\rho\frac{L}{A}\Rightarrow\rho=\frac{RA}{L}=ohm\times cm$

16. **(b)** $1\ yard=36\,inches=36\times2.54\,cm=0.9144m$.

17. **(b)** A $(1, a, b)$; B $(a, 2, b)$; C $(a, b, 3)$

$AB=(a-1)\hat{i}+(2-a)\hat{j}+0\hat{k}$

$=\lambda\,\overrightarrow{BC}=\lambda(0\hat{i}+(b-2)\hat{j}+(3-2)\hat{k})$

where $\lambda\neq0$

Hence $a-1=0 \quad \Rightarrow a=1$ ...(i)

$2-a=\lambda(b-2)$ ...(ii)

And $3-b=0 \quad \Rightarrow b=3$ ...(iii)

With $a=1$ and $b=3,\ \lambda=1$

Hence $a+b=4$

18. **(c)** $\hat{R}=\frac{\vec{R}}{|R|}=\frac{\hat{i}+\hat{j}}{\sqrt{1^2+1^2}}$

$=\frac{1}{\sqrt{2}}\hat{i}+\frac{1}{\sqrt{2}}\hat{j}$

19. **(a)** Here, $L=\sqrt{H^2+x^2}$

or $L^2=\sqrt{H^2+x^2}$

Differentiating,

$2L\left(\frac{dL}{dt}\right)=0+2x\left(\frac{dx}{dt}\right)$

But $\frac{dL}{dt}$ is velocity of the mass

and $\left(\frac{dx}{dt}\right)$ is velocity of motorcycle.

$\therefore \quad L\upsilon_m=x\upsilon$

or $\quad \upsilon_m=\frac{x\upsilon}{L}=\frac{x\upsilon}{\sqrt{H^2+x^2}}$

20. **(c)** Suppose the body e projected vertically upwards form A with a speed x. Using equation $s=ut+(1/2)at^2$.

$h=-xt_1+(1/2)gt_1^2$ ...(i)

For the second case, $h=xt_2+(1/2)gt_2^2$ ...(ii)

Subtracting eq. (1) from eq. (2),

$0=x(t_2+t_1)+(1/2)g(t_2^2+t_1^2)$

or $\quad x=(1/2)g(t_1+t_2)$ ...(iii)

Subtracting for x in eq. (2),

$h=(1/2)g(t_1-t_2)t_2+(1/2)gt_2^2=(1/2)gt_1t_2$ ...(iv)

If the body falls freely for t second, $u=0$

$\therefore \quad h=0\times t+(1/2)gt^2$

or $\quad h=(1/2)gt^2$ ...(v)

Combining eq. (4) and eq. (5), we get

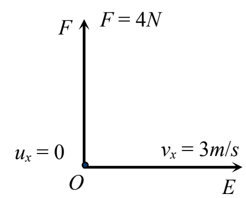
$\frac{1}{2}gt^2=\frac{1}{2}gt_1t_2$

or $\quad t=\sqrt{t_1t_2}$

21. **(b)** When a sudden jerk is given to C, an impulsive tension exceeding the breaking tension develops in C first, which breaks before this impulse can reach A as a wave through block.

22. **(b)** Displacement of body in 4 *sec* along OE

$s_x=v_xt=3\times4=12\ m$



Force along OF (perpendicular to OE) = 4 N

$\therefore \quad a_y=\frac{F}{m}=\frac{4}{2}=2\,m/s^2$

Displacement of body in 4 *sec* along OF

$\Rightarrow \quad s_y=u_yt+\frac{1}{2}a_yt^2=\frac{1}{2}\times2\times(4)^2=16m$ [As $u_y=0$]

$\therefore$ Net displacement $s=\sqrt{s_x^2+s_y^2}=\sqrt{(12)^2+(16)^2}=20\ m$

23. **(a)** $\upsilon=\frac{dx}{dt}=3-8t+3t^2$

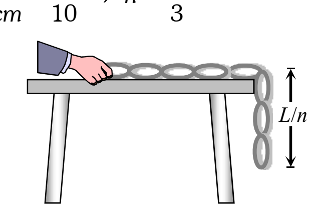
$\therefore \quad \upsilon_0=3\,m/s$ and $\upsilon_4=19m/s$

$W=\frac{1}{2}m(\upsilon_4^2-\upsilon_0^2)$ (According to work energy theorem)

$=\frac{1}{2}\times0.03\times(19^2-3^2)=5.28\,J$

24. **(b)** Fraction of length of the chain hanging from the table

$=\frac{1}{n}=\frac{60cm}{200cm}=\frac{3}{10}\Rightarrow n=\frac{10}{3}$



Work done in pulling the chain on the table:

$W=\frac{mgL}{2n^2}=\frac{4\times10\times2}{2\times(10/3)^2}=3.6J$

25. **(d)** $I = \frac{1}{2}MR^2$

26. **(a)** $I_{remaining} = I_{whole} - I_{removed}$

or $I = \frac{1}{2}(9M)(R)^2 - \left[\frac{1}{2}m\left(\frac{R}{3}\right)^2 + \frac{1}{2}m\left(\frac{2R}{3}\right)^2\right]$ . . . (i)

Here, $m = \frac{9M}{\pi R^2} \times \pi\left(\frac{R}{3}\right)^2 = M$

Substituting in equation (i),

we have $I = 4MR^2$

27. **(a)** Maximum acceleration $= a\omega^2 = a \times 4\pi^2 n^2$

$= 0.01 \times 4 \times (\pi)^2 \times (60)^2 = 144\pi^2 m/\sec$

28. **(b)** $\omega = \frac{2\pi}{T} = 100\pi \Rightarrow T = 0.02$ sec

29. **(d)** According to Kepler's law $T^2 \propto R^3$

If N is the frequency then $N^2 \propto (R)^{-3}$

or $\frac{N_2}{N_1} = \left(\frac{R_2}{R_1}\right)^{-3/2} \Rightarrow \frac{R_1}{R_2} = \left(\frac{N_2}{N_1}\right)^{2/3}$

30. **(a)** $g = \frac{4}{3}\pi G\rho R$

$\Rightarrow g \propto \rho R \Rightarrow \frac{g_e}{g_m} = \frac{\rho_e}{\rho_m} \times \frac{R_e}{R_m}$

$\Rightarrow \quad \frac{6}{1} = \frac{5}{3} \times \frac{R_e}{R_m} \Rightarrow R_m = \frac{5}{18}R_e$

31. **(c)** Mean pressure at walls

$= \left(\frac{0+h}{2}\right)dg = \frac{hdg}{2}$

32. **(b)** Let V be volume of hydrometer below neck and V' the volume of neck, then

$Mg = (V + V')\sigma_w$ . . .(i)

$Mg = V(1.5\sigma_w)$ . . .(ii)

$\therefore \quad (V + V')\sigma_w = 1.54\,V\sigma_w\; V' = 0.5$ . . .(iii)

Again $Mg = \left(V + \frac{V'}{2}\right)\sigma_l = \left(V + \frac{0.5\,V}{5}\right)\sigma_l$ . . .(iv)

From (ii) $\quad 1.5\,V\sigma_w = (1.25V)\,\sigma_l \quad \frac{\sigma_l}{\sigma_w} = \frac{1.5}{1.25} = 1.2$

33. **(b)** $l = \frac{FL}{AY} \Rightarrow \frac{l_S}{l_{cu}} = \frac{Y_{cu}}{Y_S}$ (F,L and Y are constant)

$\therefore \quad \frac{l_s}{l_{cu}} = \frac{1.2 \times 10^{11}}{2 \times 10^{11}} = \frac{3}{5}$

34. **(a)** Thermal stress

$= 1.2 \times 10^{11} \times 1.1 \times 10^{-5} \times (20 - 10) = 1.32 \times 10^7\ N/m^2$

35. **(b)** Wave velocity

$v = \frac{\text{coefficient of } t}{\text{coefficient of } x} = \frac{2\pi f}{2x/\lambda} = \lambda f$

Maximum particle velocity $v_{pm} = \omega A = 2\pi f y_0$

Given, $v_{pm} = 4v$

or $\quad 2\pi f y_0 = 4\lambda f$

$\therefore \quad \lambda = \frac{\pi y_0}{2}$

36. **(b)** The motorcyclist observes no beats. So, the apparent frequency observed by him from the two sources must be equal.

$$f_1 = f_2$$

$176\left(\frac{330 - v}{330 - 22}\right) = 165\left(\frac{330 + v}{330}\right)$

Solving this equation, we get v = 22 m/s

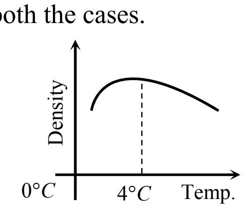
37. **(b)** Loss in time per second

$\frac{\Delta T}{T} = \frac{1}{2}\alpha\Delta\theta = \frac{1}{2}\alpha\,(t - 0)$

$\Rightarrow$ Loss in time per day

$\Delta t = \left(\frac{1}{2}\alpha t\right)t = \frac{1}{2}\alpha t \times (24 \times 60 \times 60) = \frac{1}{2}\alpha t \times 86400$

38. **(c)** Water has maximum density at 4° C, so if the water is heated above 4° C or cooled below 4° C density decreases *i.e.* volume increases. In other words, it expands so it overflows in both the cases.



39. **(b)** Let C_V = specific heat of the mixture

$C_V = \frac{n_1 C_{v_1} + n_2 C_{v_2}}{n_1 + n_2}$

$C_V = \frac{1 \times \frac{3}{2}R + 3 \times \frac{5}{2}R}{1 + 3}$

$C_V = \frac{9R}{4}$

40. **(c)** According to Boyle's law: $(P_1V_1)_{\text{bottom}} = (P_2V_2)_{\text{top}}$

$$(10+h)\times\frac{4}{3}\pi r_1^3 = 10\times\frac{4}{3}\pi r_2^3$$

But $r_2 = 2r_1$

$\therefore \quad (10+h)r_1^3 = 10\times 8r_1^3 \Rightarrow 10+h = 80$

$\therefore \quad h = 70m$

41. **(a)** $x = 3\sin 2t + 4\cos 2t.$

From given equation

$a_1 = 3, a_2 = 4,$ and $\phi = \frac{\pi}{2}$

$\therefore \quad a = \sqrt{a_1^2 + a_2^2} = \sqrt{3^2+4^2} = 5$

$\Rightarrow \quad v_{\max} = a\omega = 5\times 2 = 10$

42. **(b)** Heat released by 5 kg of water when its temperature falls from 20°C to 0°C is,

$Q_1 = mc\Delta\theta = (5)(10^3)(20-0) = 10^5$ cal

When 2 kg of ice at -20°C comes to a temperature of 0°C, it takes energy:

$Q_2 = mc\Delta\theta = (2)(500)(20) = 0.2\times 10^5$ cal

The remaining heat $Q = Q_1 - Q_2 = 0.8\times 10^5$ cal will melt a mass *m* of the ice,

Where, $m = \frac{Q}{L} = \frac{0.8\times 10^5}{80\times 10^3} = 1$ kg

So, the temperature of the mixture will be 0°C, mass of water in it is 5 + 1 = 6 kg and mass of ice is 2 – 1 = 1 kg.

43. **(b)** $Q \propto \frac{A}{l} \propto \frac{r^2}{l} \Rightarrow \frac{Q_2}{Q_1} = \frac{r_2^2}{r_1^2}\times\frac{l_1}{l_2}$

$\Rightarrow \quad \frac{Q_2}{Q_1} = \frac{4}{1}\times\frac{1}{2} \Rightarrow Q_2 = 2Q_1$

44. **(c)** $\frac{Q}{t} = \frac{KA(\theta_1-\theta_2)}{l} \Rightarrow \frac{Q}{t} \propto \frac{A}{l} \propto \frac{r^2}{l}$

[As $(\theta_1 - \theta_2)$ and *K* are constants]

$$\Rightarrow \frac{\left(\frac{Q}{t}\right)_1}{\left(\frac{Q}{t}\right)_2} = \frac{r_1^2}{r_2^2}\times\frac{l_2}{l_1} = \frac{4}{9}\times\frac{2}{1} = \frac{8}{9}$$

45. **(c)** $\frac{T_1}{T_2} = \frac{\lambda_{m_2}}{\lambda_{m_1}} = \frac{5.5\times 10^5}{11\times 10^5} = \frac{1}{2}$

$\Rightarrow \quad n = \frac{1}{2}.$

46. **(b)** Work done,

$W = P\Delta V = 2\times 10^5\,(150-50)\times 10^{-3} = 2\times 10^4$ J

47. **(b)** According to first Law of thermodynamics

$\Delta Q = \Delta U + \Delta W$

$\therefore \quad \frac{\Delta Q}{\Delta t} = \frac{\Delta U}{\Delta t} + \frac{\Delta W}{\Delta t}$

Here, $\frac{\Delta Q}{\Delta t} = 120$W,

$\frac{\Delta W}{\Delta t} = 80\text{Js}^{-1}$

$\therefore \quad \frac{\Delta U}{\Delta t} = 120 - 80 = 40\ \text{Js}^{-1}$

48. **(c)** Since volume of water remains constant, then work done

$\Delta W = PdV = 0$

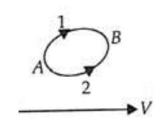
According to first pair of thermodynamics

$dQ = dU + dW,\ dU = dQ = mS\Delta T$

$= 1\times 4148\times(70-40) = 4148\times 30$

$= 124440\ \text{J} = 1.244\times 10^5$ J

49. **(d)** The change in internal energy of system will be same for both paths 1 and 2.



Along path 1, $\Delta Q_1 = \Delta U + \Delta W_1$ …(i)

Along path 2, $\Delta Q_2 = \Delta U + \Delta W_2$ …(ii)

Subtract (ii) from (i), we get

or $AQ_1 - AQ_2 = \Delta W^1 - \Delta W_2$

$1100 - AQ_2 = 150$

$AQ_2 = 1100 - 150 = 950$ J

50. **(a)** Here, volume of water heated = 4 litre min^{-1}.

1 litre = 1000 g,

then mass of water = 4×1000 g min^{-1} = 4000 g min^{-1}

Rise in temperature

$\Delta T = T_2 - T_1, = (85-30)°C = 55°C$

Specific heat of water, s = 4.2 J $g^{-1}°C^{-1}$

The amount of heat used, $\Delta Q = MS\Delta T$

$= 4000\times 4.2\times 55 = 924000$

$= 9.24\times 10^5$ J min^{-1}

❑❑❑