PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 18

Total Marks : 36

Max. Time : 39 min.

Topics : Calorimetry & Thermal Expansion, Electrostatics, Work, Power and Energy, Rigid Body Dynamics, String Wave, Geometrical Optics

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.5	(3 marks, 3 min.)	[15, 15]
Subjective Questions ('–1' negative marking) Q.6	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4)	(8 marks, 10 min.)	[8, 10]

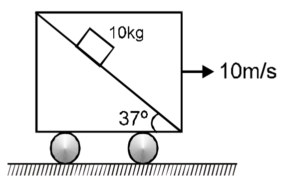
1. Water of mass m_2 = 1 kg is contained in a copper calorimeter of mass m_1 = 1 kg. Their common temperature t = 10°C. Now a piece of ice of mass m_3 = 2 kg and temperature is –11°C dropped into the calorimeter. Neglecting any heat loss, the final temperature of system is. [specific heat of copper = 0.1 Kcal/ kg°C, specific heat of water = 1 Kcal/kg°C, specific heat of ice = 0.5 Kcal/kg°C, latent heat of fusion of ice = 78.7 Kcal/kg]

(A) 0°C (B) 4°C (C) – 4°C (D) – 2°C

2. Two identical spheres of same mass and specific gravity (which is the ratio of density of a substance and density of water) 2.4 have different charges of Q and – 3Q. They are suspended from two strings of same length ℓ fixed to points at the same horizontal level, but distant ℓ from each other. When the entire set up is transferred inside a liquid of specific gravity 0.8, it is observed that the inclination of each string in equilibrium remains unchanged. Then the dielectric constant of the liquid is

(A) 2 (B) 3 (C) 1.5 (D) None of these

3. A block of mass 10 kg is released on a fixed wedge inside a cart which is moved with constant velocity 10 m/s towards right. Take initial velocity of block with respect to cart zero. Then work done by normal reaction (with respect to ground) on block in two seconds will be: (g = 10 m/s^2).

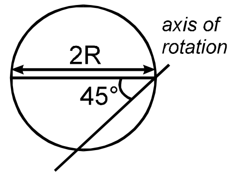


(A) zero (B) 960 J
(C) 1200 J (D) none of these

4. If the frequency of a wave is increased by 25 %, then the change in its wavelength will be: (medium not changed)

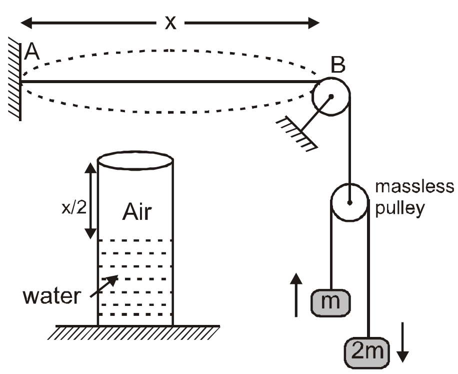
(A) 20 % increase (B) 20 % decrease (C) 25 % increase (D) 25 % decrease

5. The moment of inertia of a thin sheet of mass M of the given shape about the specified axis is



(A) $(3/2)MR^2$ (B) $(3/4)MR^2$
(C) $MR^2 (1 + 1/\sqrt{2})$ (D) $MR^2/(2\sqrt{2})$

6. AB wire is vibrating in its fundamental mode. Wire AB is in resonance with resonance tube in which air column is also vibrating with its fundamental mode. Sound speed is 400 m/sec and linear mass density of AB wire is 10^{-4} kg/m and g = 10 m/sec^2, value of mass m = [$\beta(10^{-1})$] kg, then find value of β.Neglect the masses of wires in comparison to block's mass 'm'.



COMPREHENSION

A glass prism with a refracting angle of 60^0 has a refractive index 1.52 for red and 1.6 for violet light. A parallel beam of white light is incident on one face at an angle of incidence, which gives minimum deviation for red light. Find :

[**Use:** sin (50º) = 0.760; sin (31.6º) = 0.520 ; sin (28.4º) = 0.475; sin (56º) = 0.832 ; π = 22/7]

7. The angle of incidence at the prism is :

(A) 30º (B) 40º (C) 50º (D) 60º

8. The angular width of the spectrum is :

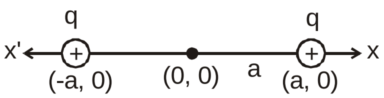
(A) 6º (B) 4.8º (C) 9.6º (D) 12º

9. The length of the spectrum if it is focussed on a screen by a lens of focal length 100 cm is :

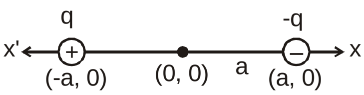
(A) $\frac{10\pi}{3}$cm (B) $\frac{10\pi}{3}$m (C) $\frac{5\pi}{3}$cm (D) $\frac{5\pi}{3}$m

10. The column I gives the two point charge system separated by 2a and the column II gives the variation of magnitude of electric field intensity at point on the x-axis. Match the situation in Column I with the results in Column II and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in the OMR.

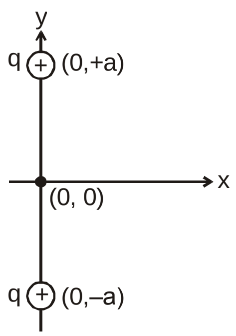
Column – I | **Column – II**

(A) 

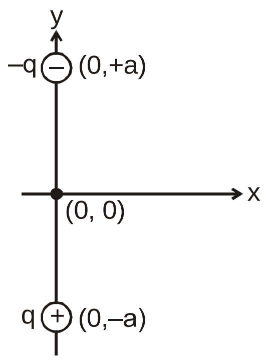
(p) Increases as x increases in the interval $0 \leq x < a$

(B) 

(q) Decreases as x increases in the interval $0 \leq x < a$

(C) 

(r) Zero at x = 0

(D) 

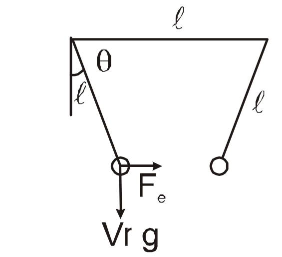
(s) Decreases as x increases in the interval $a < x < \infty$

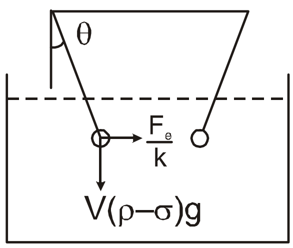
Answers Key

1. (A) **2.** (C) **3.** (B) **4.** (B)
5. (B) **6.** 6 **7.** (C) **8.** (A)
9. (A) **10.** (A) $\rightarrow$ (p, r, s), (B) $\rightarrow$ (p, s), (C) $\rightarrow$ (r, s), (D) $\rightarrow$ (q, s)

Hints & Solutions

1. Loss in heat from calorimeter + water as temperture changes from 10°C to 0°C
$= m_1C_1 10 + m_2C_2 10$
$= 1 \times 1 \times 10 + 1 \times 0.1 \times 10 = 11$ kcal
Gain in heat of ice as its temperature changes from –11°C to 0°C
$= m_3C_3 \times 11 = 2 \times 0.5 \times 11 = 11$ kcal
Hence ice and water will coexist at 0°C without any phase change.

2. 

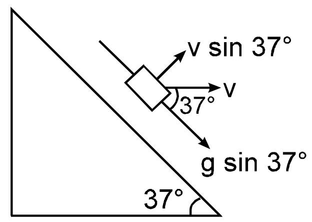


$$\tan\theta = \frac{F_e}{V\rho g} = \frac{F_e / k}{V(\rho - \sigma)g}$$

$$\Rightarrow \quad k = \frac{\rho}{\rho - \sigma} = \frac{2.4}{2.4 - 0.8} = 1.5$$

$$\mathbf{k = \frac{\rho}{\rho - \sigma} = \frac{2.4}{2.4 - 0.8} = 1.5}$$

3. Because the acceleration of wedge is zero, the normal reaction exerted by wedge on block is
$N = mg \cos 37°$.
The acceleration of the block is g sin 37° along the incline and initial velocity of the block is v = 10 m/s horizontally towards right as shown in figure.



The component of velocity of the block normal to the incline is v sin 37°. Hence the displacement of the block normal to the incline in t = 2 second is

$$S = v \sin 37° \times 2 = 10 \times \frac{3}{5} \times 2 = 12 \text{ m.}$$

∴ The work done by normal reaction

$$W = mg \cos 37° \quad S = 100 \times \frac{4}{5} \times 12 = 960 \text{ J}$$

4. Since, the medium has not changed, speed of wave remains same.

⇒ $v = f\lambda$ = constant
$f_1\lambda_1 = f_2 \lambda_2$
⇒ $f_1\lambda_1 = (1.25f_1)\lambda_2$
(∵ frequency increased by 25%)

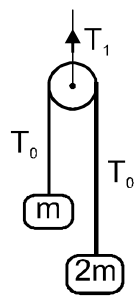
⇒ $\lambda_2 = \frac{\lambda_1}{1.25}$

⇒ λ_2 decreases.
⇒ % change in wavelength

$$= \frac{\lambda_1 - \lambda_2}{\lambda_1} \times 100 = \frac{\lambda_1 - \frac{\lambda_1}{1.25}}{\lambda_1} \times 100$$

$$= \frac{0.25}{1.25} \times 100 = \frac{100}{5} = 20\%$$

6.



$$T_1 = 2T_0 = 2\left[\frac{2m(2m)}{m + 2m}\right]g$$

$T_1 = \frac{8m}{3}g = \frac{80m}{3}$ ....(i)

In resonance,

$f_{wire} = f_{tube}$

$$\frac{(1)V_1}{2\ell_1} = \frac{(1)V_2}{4\ell_2}$$

$$\frac{\left(\sqrt{\frac{T_1}{\mu}}\right)}{2(x)} = \frac{(400)}{4\left(\frac{x}{2}\right)}$$

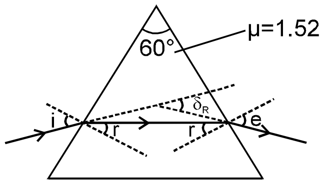
$\Rightarrow$ $T_1 = \mu(16 \times 10^4)$

From (i),

$$\frac{80}{3} m = 10^{-4} (16 \times 10^4)$$

m = 0.6 kg.

7.



$\mu_R = 1.52$

$\mu_v = 1.6$

Minimum deviation condition for red is r = 30°

$\Rightarrow$ (1) sin i = (1.52) sin30°

i = 50º,

δ_R = (50º) 2 – 60°

= 40°

8. For violet light

(1) sin 50° = (1.6) sin r

$\therefore$ r = 28.4°

r′ = 31.6° ($\because$ r + r′ = A)

(1) sin e = (1.6) sin 31.6°

$\therefore$ e = 56°,

$\Rightarrow$ δ_v = i + e – A = 50º + 56° – 60°

= 46°

$\therefore$ angular width = $\delta_v - \delta_R$ = 6°

9. The length of the spectrum if it is focussed on a screen by a lens of focal length 100 cm is :

(A*) $\frac{10\pi}{3}$cm (B) $\frac{10\pi}{3}$m

(C) $\frac{5\pi}{3}$cm (D) $\frac{5\pi}{3}$m

Sol. if θ = $100 \times 6 \times \frac{\pi}{180}$ cm = $\frac{10\pi}{3}$cm

10. (A) $\rightarrow$ (p, r, s), (B) $\rightarrow$ (p, s),(C) $\rightarrow$ (r, s), (D) $\rightarrow$ (q, s)