PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 25

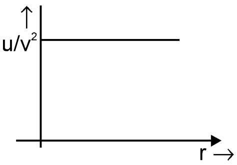
Total Marks : 32

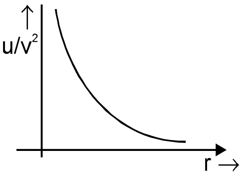
Max. Time : 33 min.

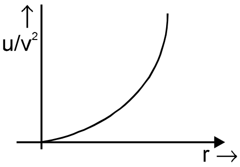
Topics : Electrostatics, Circular Motion, Geometrical Optics , Relative Motion, Work, Power and Energy, Fluid

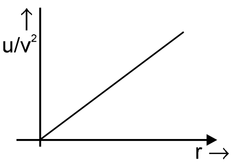
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.5	(3 marks, 3 min.)	[15, 15]
Multiple choice objective ('–1' negative marking) Q.6	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.7	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.8 to Q.10	(3 marks, 3 min.)	[9, 9]

1. At distance ' r ' from a point charge, the ratio $\frac{U}{V^2}$ (where ' U ' is energy density and ' V ' is potential) is best represented by :

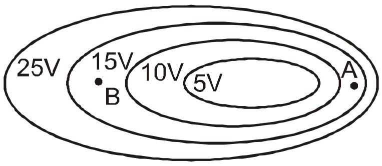
(A) 

(B) 

(C) 

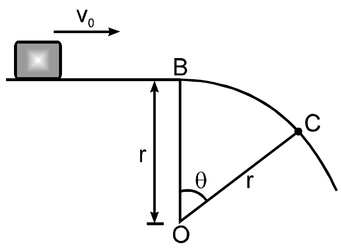
(D) 

2. The figure shows several equipotential lines. Comparing between points A and B, pick up the best possible statement



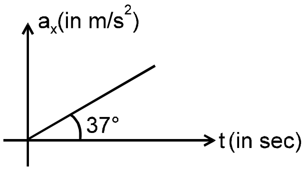
(A) the electric field has a greater magnitude at point A and is directed to left.
(B) the electric field has a greater magnitude at point A and is directed to right.
(C) the electric field has a greater magnitude at point B and is directed to left.
(D) the electric field has a greater magnitude at point B and is directed to right.

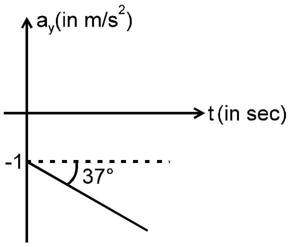
3. A small block slides with velocity $0.5\sqrt{gr}$ on the horizontal frictionless surface as shown in the Figure. The block leaves the surface at point C. The angle θ in the Figure is:



(A) $\cos^{-1}(4/9)$
(B) $\cos^{-1}(3/4)$
(C) $\cos^{-1}(1/2)$
(D) none of the above

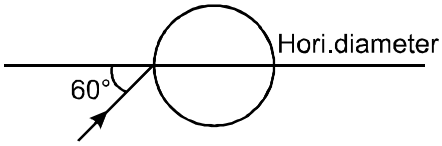
4. In the figure the variation of components of acceleration of a particle of mass 1 kg is shown w.r.t. time. The initial velocity of the particle is $\vec{u} = (-3\hat{i} + 4\hat{j})$ m/s. The total work done by the resultant force on the particle in time interval from t = 0 to t = 4 seconds is :





(A) 22.5 J
(B) 10 J
(C) 0
(D) None of these

5. A ray of light falls on a transparent sphere as shown in figure. If the final ray emerges from the sphere parallel to the horizontal diameter, then the refractive index of the sphere is (consider that sphere is kept in air) :

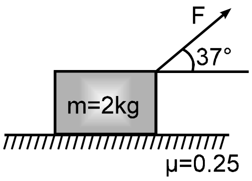


(A) $\sqrt{2}$ (B) $\sqrt{3}$

(C) $\frac{3}{\sqrt{2}}$ (D) 2

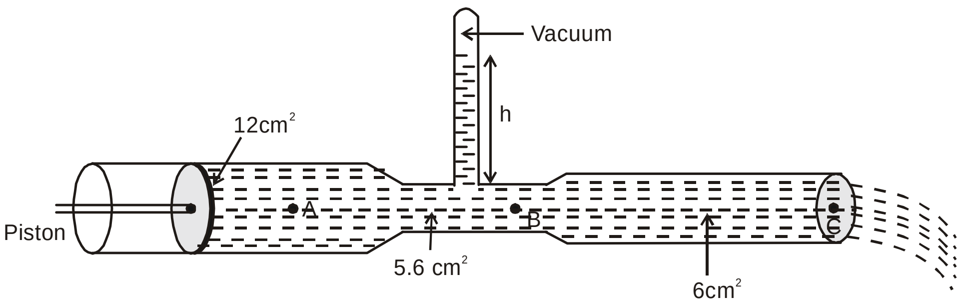
6. A boat moves relative to river with a velocity which is n times the river flow velocity.
(A) If $n < 1$, boat cannot cross the river
(B) If $n = 1$, boat cannot cross the river without drifting
(C) If $n > 1$, boat can cross the river along shortest path
(D) Boat can cross the river whatever is the value of n (excluding zero)

7. A force F = 20 N is applied to a block (at rest) as shown in figure. After the block has moved a distance of 8 m to the right, the direction of horizontal component of the force F is reversed. Find the velocity with which block arrives at its starting point.



COMPREHENSION

A glass tube has three different cross sectional areas with the values indicated in the figure. A piston at the left end of the tube exerts pressure so that the mercury within the tube flows from the right end with a speed of 8.0 m/s. Three points within the tube are labeled A, B and C. The atmospheric pressure is 1.01×10^5 N/m^2; and the density of mercury is 1.36×10^4 kg/m^3. (use g = 10 m/s^2)



8. At what speed is mercury flowing through the point A ?
(A) 2.0 m/s (B) 4.0 m/s (C) 8.0 m/s (D) 12 m/s

9. The pressure at point A is equal to:
(A) 2.02×10^5 Pa (B) 2.25×10^5 Pa (C) 3.26×10^5 Pa (D) 4.27×10^5 Pa.

10. The height h of mercury in the manometer is
(A) 136 mm (B) 169 mm (C) 272 mm (D) 366 mm

Answers Key

1. (B) **2.** (A) **3.** (B) **4.** (B)

5. (B) **6.** (B,C,D) **7.** $V = \frac{16\sqrt{7}}{3} m/s$

8. (B) **9.** (D) **10.** (C)

Hints & Solutions

1. $U = \frac{1}{2}\varepsilon_0 \quad E^2 = \frac{1}{2}\frac{\varepsilon_0 K^2 Q^2}{r^4}$

$V = \frac{KQ}{r}$

$$\frac{U}{V^2} = \frac{\frac{1}{2}\varepsilon_0 K^2 \frac{Q^2}{r^4}}{\frac{K^2Q^2}{r^2}} = \frac{1}{2}\frac{\varepsilon_0}{r^2}$$

because $\frac{U}{V^2} \propto \frac{1}{r^2}$

so the correct option is B.

2. The magnitude of the electric field is maximum where the equipotentials are close together. The direction of the field is from high potential to low potential.

4. From given graphs :

$a_x = \frac{3}{4}t$ and $a_y = -\left(\frac{3}{4}t+1\right)$

$\Rightarrow v_x = \frac{3}{8}t^2 + C$

At $t = 0 : v_x = -3$

$\Rightarrow C = -3$

$\therefore v_x = \frac{3}{8}t^2 - 3$

$\Rightarrow dx = \left(\frac{3}{8}t^2 - 3\right)dt \qquad .... (1)$

Similarly

$$dy = \left(-\frac{3}{8}t^2 - t + 4\right)dt \quad .... (2)$$

As $dw = \vec{F}.\overrightarrow{ds} = \vec{F}.(dx\,\hat{i} + dy\,\hat{j})$

$$\therefore \int_0^w dw = \int_0^4 \left[\frac{3}{4}t\,\hat{i} - \left(\frac{3}{4}t+1\right)\hat{j}\right].\left[\left(\frac{3}{8}t^2 - 3\right)\hat{i} + \left(-\frac{3}{8}t^2 - t + 4\right)\hat{j}\right]dt$$

$\therefore$ **W = 10 J**

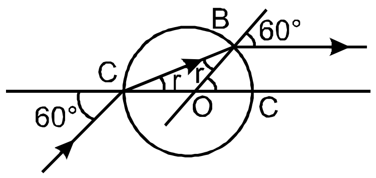
Alternate Solution :

Area of the graph ;

$\int a_x\, dt = 6 = V_{(x)f} - (-3) \Rightarrow V_{(x)f} = 3.$

and $\int a_y\, dt = -10 = V_{(y)f} - (4) \Rightarrow V_{(y)f}$
$= -6.$

Now work done $= \Delta KE = 10$ J

5. 

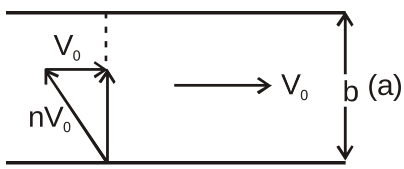
In diagram angle of emergence = 60°

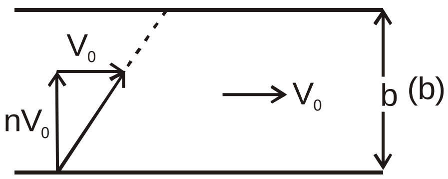
$\therefore \angle BOC = 60°$

$\therefore r + r = 60°$

$\Rightarrow r = 30°$

$\therefore \mu = \frac{\sin 60°}{\sin 30°} \Rightarrow \mu = \sqrt{3}$

6. 



If V_0 be the flow velocity of the river, then velocity of boat relative to water = nV_0.

If the boat has to adopt the shortest path, then direction of velocity of boat relative to water should make an angle greater than 90° with the flow direction of river

Resultant velocity of boat $= \sqrt{(nV_0)^2 - V_0^2}$. This velocity can have a real value only when n > 1. If n = 1, then resultant velocity = 0. So the boat will follow the shortest path only when n > 1. So options (b) and (c) are correct.

If boat is moved normal to flow direction, then it will cross the river in a time $\frac{b}{nV_0}$, where b is the width of the river. If $n \neq 0$, the boat will cross the river. So option (d) is also correct.

7. $\mu N = 2$, $N = 8$, $a = \frac{16-2}{2} = 7$ $(\rightarrow)$

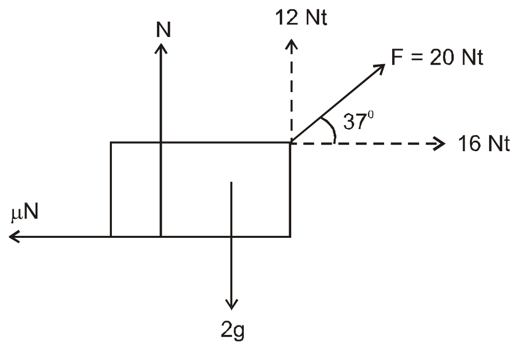
$v^2 = 2\,(7)\,8$ $\rightarrow$ ....(i)

when the direction of horizontal component of the force F is reversed

$a_1 = 9\ m/s^2$ $(\leftarrow)$

and distance covered by the block before it stops

$= s_1 = \frac{16 \times 7}{2 \times 9}$



Again $s_2 = 8 + s_1 = 8 + \frac{16 \times 7}{2 \times 9}$

and $a_2 = 7$ $(\leftarrow)$

$v^2 = 0 + 2\,(a_2)\,(s_2) = 2\,(7)\left(8 + \frac{16 \times 7}{2 \times 9}\right)$

$\Rightarrow$ $v = \frac{16\sqrt{7}}{3}$ m/s

8. Using equation of continuity $A_1v_1 = A_2v_2$

$(12\ cm^2)v_A = (6\ cm^2)\ (8.0\ m/s)$

$v_A = 4.0\ m/s$

9. Applying Bernoulli's principle between point A and C that are at same horizontal level

$$\frac{1}{2}\rho.V_A{}^2 + p_A = \frac{1}{2}\rho.V_C{}^2 + p_{atm}$$

$$\Rightarrow \quad p_A = (1.01 \times 10^5\ N/m^2) + \frac{1}{2} \times 13{,}600\ (8^2 - 4^2)$$

$$= \quad 4.27 \times 10^5\ N/m^2$$

10. By applying Bernoulli's equation between point B and C and using equation of continuity

$v_B = 8.57\ m/s$

and $p_B = 3.70 \times 10^4$ Pascal

$\rho gh = 3.70 \times 10^4$

$$h = \frac{3.70 \times 10^4}{10 \times 13{,}600} = \quad 272\ mm$$