PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 55

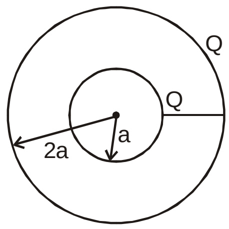
Total Marks : 25

Max. Time : 26 min.

Topics : Electrostatics, Current Electricity, Capacitor, Gravitation, Rotation, Center of Mass

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.6 to Q.10	(3 marks, 3 min.)	[15, 15]

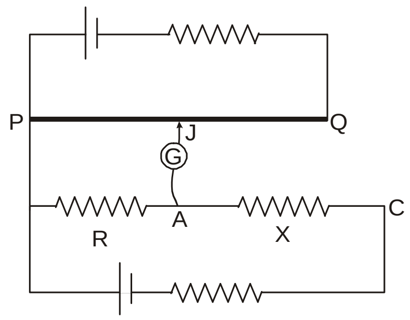
1. Figure shows a solid metal sphere of radius a surrounded by a concentric thin metal shell of radius 2a. Initially both are having charges Q each. When the two are connected by a conducting wire as shown in the figure, then amount of heat produced in this process will be



(A) $\frac{KQ^2}{2a}$ (B) $\frac{KQ^2}{4a}$

(C) $\frac{KQ^2}{6a}$ (D) $\frac{KQ^2}{8a}$

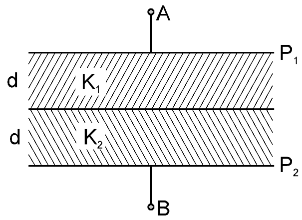
2. Circuit for the measurement of resistance by potentiometer is shown. The galvanometer is first connected at point A and zero deflection is observed at length PJ = 10 cm. In second case it is connect at point C and zero deflection is observed at a length 30 cm from P. Then the unknown resistance X is



(A) 2R (B) $\frac{R}{2}$

(C) $\frac{R}{3}$ (D) 3R

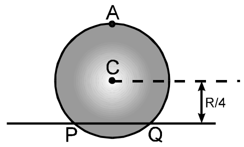
3. In the figure shown P_1 and P_2 are two conducting plates having charges of equal magnitude and opposite sign. Two dielectrics of dielectric constant K_1 and K_2 fill the space between the plates as shown in the figure. The ratio of electrical energy in 1[st] dielectric to that in the 2[nd] dielectric is



(A) 1 : 1
(B) $K_1 : K_2$
(C) $K_2 : K_1$
(D) $K_2^2 : K_1^2$

4. The gravitational potential energy of a satellite revolving around the earth in circular orbit is – 4 MJ. Find the additional energy (in MJ) that should be given to the satellite so that it escapes from the gravitational field of earth. Assume earth's gravitational force to be the only gravitational force on the satellite and no atmospheric resistance.

5. A uniform circular disc has radius R and mass m. A particle also of mass m is fixed at a point A on the periphery of the disc as shown in figure. The disc can rotate freely about a fixed horizontal chord PQ that is at a distance R/4 from the centre C of the disc. The line AC is perpendicular to PQ. Initially the disc is held vertical with the point A at its highest position. It is then allowed to fall so that it starts rotating about PQ. Find the linear speed of the particle when it reaches its lowest position. Acceleration due to gravity is g.



COMPREHENSION

Two friends A and B (each weighing 40 kg) are sitting on a frictionless platform some distance d apart. A rolls a ball of mass 4 kg on the platform towards B which B catches. Then B rolls the ball towards A and A catches it. The ball keeps on moving back and forth between A and B. The ball has a fixed speed of 5 m/s on the platform.

6. Find the speed of A after he rolls the ball for the first time

(A) 0.5 m/s (B) 5m/s (C) 1 m/s (D) None of these

7. Find the speed of A after he catches the ball for the first time.

(A) $\frac{10}{21}$ m/s (B) $\frac{50}{11}$ m/s (C) $\frac{10}{11}$ m/s (D) None of these

8. Find the speeds of A and B after the ball has made 5 round trips and is held by A :

(A) $\frac{10}{11}$ m/s , $\frac{50}{11}$ m/s (B) $\frac{50}{11}$ m/s, $\frac{10}{11}$ m/s (C) $\frac{50}{11}$ m/s, 5 m/s (D) None of these

9. How many times can A roll the ball ?

(A) 6 (B) 5 (C) 7 (D) None of these

10. Where is the centre of mass of the system " A + B + ball" at the end of the nth trip? (Give the distance from the initail position of A)

(A) $\frac{10}{11}$ d (B) $\frac{10}{21}$d (C) $\frac{50}{11}$ d (D) None of these

Answers Key

1.	(B)	**2.**	(A)	**3.**	(C)	**4.**	2
5.	$v = \sqrt{5gR}$			**6.**	(A)	**7.**	(C)
8.	(C)	**9.**	(A)	**10.**	(B)		

Hints & Solutions

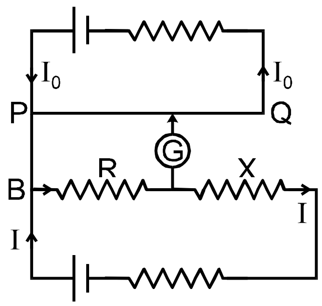
1. $E_i = \frac{KQ^2}{2a} + \frac{KQ^2}{4a} + \frac{KQ}{2a}.Q$

$= \frac{KQ^2}{a} + \frac{KQ^2}{4a} \quad = \frac{5KQ^2}{4a}$

$E_f = \frac{K(2Q)^2}{4a} = \frac{KQ^2}{a}$

$E_i - E_f = H = \frac{KQ^2}{4a}$

2. In potentiometer wire potential difference is directly proportional to length



Let potential drop unit length a potentiometer wire be K.

For zero deflection the current will flow independently in two circles

$IR = K \times 10$ .... (1)

$IR + IX = K \times 30$ .... (2)

(2) – (1)

$\Rightarrow IX = k \times 20$ .... (3)

$(1)/(2) = \frac{R}{X} = \frac{1}{2}$

3. Let σ be the charge density of conducting plate and V be the volume of either dielectric

$$\therefore \frac{U_1}{U_2} = \frac{\left(\frac{1}{2} k_1 \epsilon_0 \quad E_1^2\right) V}{\left(\frac{1}{2} k_2 \epsilon_0 \quad E_2^2\right) V}$$

$$= \frac{k_1}{k_2} \frac{\left(\frac{\sigma}{k_1 \epsilon_0}\right)^2}{\left(\frac{\sigma}{k_2 \epsilon_0}\right)^2} = \frac{k_2}{k_1}$$

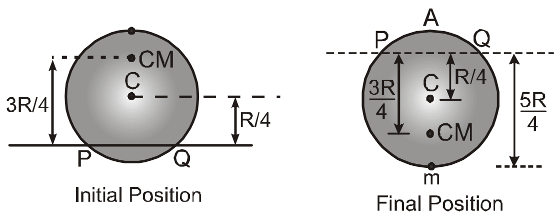
4. **2**

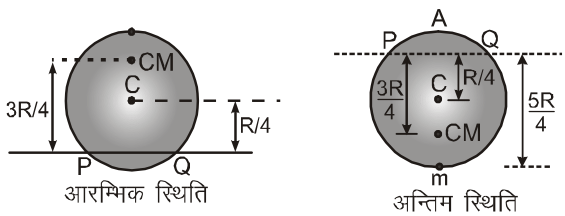
PE = –4 MJ

TE = –2MJ

The additional energy required to make the satellite escape = +2MJ.

5. Applying conservation of mech. energy.





decrease in P.E. = increase in rotational K.E.

$$\Rightarrow (2m)\, g \; 2\left(\frac{3R}{4}\right) = \frac{1}{2}\left[I_{system}\right]\omega^2$$

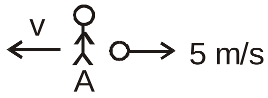
$$3\, mgR = \frac{1}{2}\,[I_{disc.} + I_{mass}]\, \omega^2$$

3 mgR

$$= \frac{1}{2}\left[\frac{mR^2}{4} + \frac{mR^2}{16} + \frac{25mR^2}{16}\right]\omega^2$$

$$\frac{3g}{R} = \frac{1}{2}\left[\frac{30}{16}\right]\omega^2 \Rightarrow \sqrt{\frac{16}{5}\frac{g}{R}} = \omega$$

$$V_{particle} = \left(\frac{5}{4}R\right)\omega = \sqrt{5gR}$$

6. (A) 

from linear momentum conservation

$$M_A V = m_b 5 \Rightarrow v = \frac{4 \times 5}{40} = 0.5 \text{ m/s Ans.}$$

7. (C)

$m_A\, 0.5 + m_b\, 5 = (M_A + m_b)\, V_1$

$$V_1 = \frac{40 \times 0.5 + 4 \times 5}{44} = \frac{40}{44} = \frac{10}{11} \text{ m/s} \quad \textbf{Ans.}$$

8. (C)

after throught the ball velocity of man A is 0.5 m/s

For man B

$4 \times 5 = 40\, v_2 - 4 \times 5 \Rightarrow v_2 = 1$ m/s

velocity B is 1 m/s after through the ball

after through the ball second time, velocity of man A is

$4 \times 5 + 40 \times 0.5 = 40 \times v_3 - 4 \times 5$

$v_3 = 1.5$ m/s

similarly for man B $v_4 = 2$ m/s

after 5 round trip and man A hold the ball velocity of man B is 5 m/s

velocity of man A

$4.5 \times 40 + 4 \times 5 = (40 + 4)v_5$

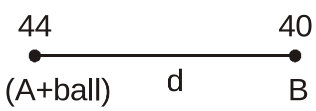
$$v_5 = \frac{50}{11} \text{ m/s} \quad \textbf{Ans.}$$

9. (A)

When man through the ball 6 times it velocity is greater than 5 m/s and velocity of B is 5 m/s therefor maximum number of times man A can through the ball is 6 .

10. $F_{ext} = 0$, Centre of mass of system cannot move

Initial position of centre of mass from A.



$$X_{cm} = \frac{40\, d}{44 + 40} = \frac{10}{21}\, d$$