

## 25-10 Electric Potential Energy of a System of Point Charges

## Question 594

25-10

0.37-60%

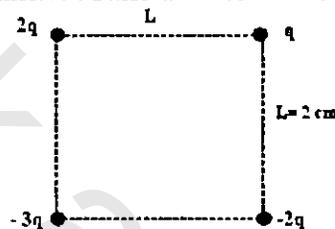
Two charged parallel plates are separated by a distance of 3 mm. If an electron starts from rest at one plate and reaches the other plate with a final speed of  $3.7 \times 10^6$  m/s, what is the change in electric potential between the initial position and the final position of the electron?

- (a) -39 V
- (b) +39 V
- (c) +24 V
- (d) -24 V
- (e) -56 V

25-10

## Question 595

Consider the four charges shown in Figure 5. How much work is required, by an external agent, to move the charge  $q$  to infinity. (Take  $q = 1.0$  micro-C.)



- (a) 0.52 J
- (b) -0.32 J
- (c) -0.95 J
- (d) 0.32 J
- (e) 0.95 J

25-10

0.28-43%

## Question 596

A metallic sphere of radius 8 cm is charged to a potential of -500 V (take  $V = 0$  at infinity). An electron is initially 15 cm from the center of the sphere. What must the initial speed of the electron be if it is to barely hit the sphere ( $v_f = 0$ )?

- (a)  $3.2 \times 10^5$  m/s
- (b) 32 m/s
- (c)  $4.5 \times 10^4$  m/s
- (d)  $9.1 \times 10^6$  m/s
- (e)  $7.8 \times 10^7$  m/s

25-10

0.31-43%

## Question 597

Two point charges, one is  $Q_1 = 6$  micro-C and located at (0, 12 cm) and the other is  $Q_2 = 6$  micro-C and located at (0, -12 cm). How much work must be done by an external agent to move a charge  $Q_3 = -6$  micro-C from the origin (0,0) to a point having coordinates (5 cm, 0)?

- (a) -308 mJ
- (b) zero
- (c) 415 mJ
- (d) 308 mJ
- (e) -415 mJ

25-10

Question 598

A particle [ $m = 8.0 \times 10^{-9}$  kg,  $q = +6.0 \times 10^{-9}$  C] has a speed of 80 m/s at point A and moves to point B where the potential is  $2.0 \times 10^3$  V greater than at point A. What is the particle's kinetic energy at point B? (Assume that only electric forces act on the particle during its motion.)

- (a)  $38 \times 10^{-6}$  J.
- (b)  $28 \times 10^{-6}$  J.
- (c)  $14 \times 10^{-6}$  J.
- (d)  $40 \times 10^{-6}$  J.
- (e)  $10 \times 10^{-6}$  J.

25-10

Question 599

Four charges,  $(-e, +e, -e, +e)$ , are arranged as in figure (2). Calculate the work required to remove the positive charge  $(+e)$  on the right side to infinity.

$$a = 3 \times 10^{-10} \text{ m}$$

$e = \text{charge of an electron}$

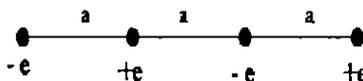


Figure 2

- (a)  $6.4 \times 10^{-19}$  J.
- (b)  $3.2 \times 10^{-19}$  J.
- (c)  $1.6 \times 10^{-19}$  J.
- (d)  $0.8 \times 10^{-19}$  J.
- (e)  $0.4 \times 10^{-19}$  J.

25-10

Question 600

In figure 2, four charges are fixed at the corners of a square whose sides are of length  $d$ . The work done by an external agent to bring a fifth charge,  $Q$ , from infinity to the center of the square is:

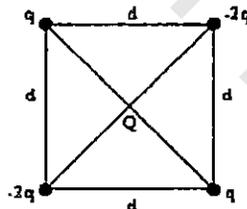


FIGURE 2

- (a)  $-2.8 \cdot k \cdot q \cdot Q/d$ .
- (b)  $3.4 \cdot k \cdot q \cdot Q/d$ .
- (c)  $1.4 \cdot k \cdot q \cdot Q/d$ .
- (d)  $1.4 \cdot k \cdot q \cdot Q/d$ .
- (e)  $2.8 \cdot k \cdot q \cdot Q/d$ .

25-10

Question 601

An electric dipole, of electric charge  $9.3 \times 10^{-12}$  C and distance  $1.0 \times 10^{-3}$  m, is in an electric field of strength 1100 N/C. What is the difference in potential energy corresponding to dipole orientations parallel and anti-parallel to the field?

- (a)  $3.87 \times 10^{-11}$  J.
- (b)  $1.03 \times 10^{-11}$  J.
- (c)  $6.15 \times 10^{-15}$  J.
- (d)  $4.08 \times 10^{-13}$  J.
- (e)  $2.05 \times 10^{-11}$  J.

## Question 602

25-10

3.54-47%

Two equal charges, each of 0.12 C, are separated by a distance of 1.8 m. What is the work done, by an external agent, to bring a charge of 0.15 C from infinity to the midpoint between the two charges?

- (a)  $2.1 \cdot 10^{**8}$  J.
- (b)  $0.6 \cdot 10^{**8}$  J.
- (c)  $1.7 \cdot 10^{**7}$  J.
- (d)  $3.6 \cdot 10^{**8}$  J.
- (e)  $2.0 \cdot 10^{**8}$  J.

## Question 603

25-10

3.21-57%

What is the electric potential energy of an electron at a distance  $r = 2.40 \cdot 10^{**(-10)}$  m from the nucleus of a hydrogen atom (the nucleus consists of a single proton)?

- (a) 6.8 eV.
- (b) -6.8 eV.
- (c) -6.0 eV.
- (d) 6.0 eV.
- (e) -8.5 eV.

## Question 604

25-10

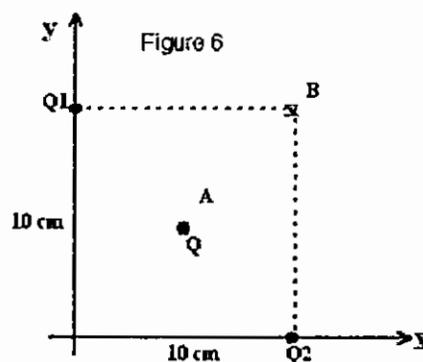
What is the external work required to bring four  $2.0 \cdot 10^{**(-9)}$  C point charges from infinity and to place them at the corner of a square of side 0.14 m

- (a)  $0.6 \cdot 10^{**(-6)}$  Joule.
- (b)  $1.4 \cdot 10^{**(-6)}$  Joule.
- (c)  $1.0 \cdot 10^{**(-6)}$  Joule.
- (d)  $0.3 \cdot 10^{**(-6)}$  Joule.
- (e)  $1.8 \cdot 10^{**(-6)}$  Joule.

## Question 605

25-10

In figure (6),  $Q_1 = 2.0 \cdot 10^{**(-6)}$  C and  $Q_2 = -2.0 \cdot 10^{**(-6)}$  C. What is the external work needed to move a charge  $Q = -4.0 \cdot 10^{**(-6)}$  C at constant speed from point A at the center of the square to point B at the corner?



- (a)  $7.2 \cdot 10^{**(-6)}$  Joule.
- (b)  $-5.1 \cdot 10^{**(-6)}$  Joule.
- (c)  $5.1 \cdot 10^{**(-6)}$  Joule.
- (d)  $-7.2 \cdot 10^{**(-6)}$  Joule.
- (e) Zero.

## Question 606

25-10  
0.43-63%

Two electrons are fixed 2.0 cm apart. Another electron is shot from infinity with a speed  $v$  and comes to rest at a point midway between the two electrons. Find  $v$ .

- (a) 255 m/s
- (b) 318 m/s
- (c) 963 m/s
- (d) 612 m/s
- (e) 742 m/s

## Question 607

25-10  
0.49-26%

What is the electric potential energy of the charge configuration shown in figure 3?

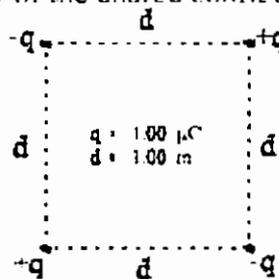


FIGURE 3

- (a) zero
- (b) + 46.5 mJ
- (c) + 23.3 mJ
- (d) - 46.5 mJ
- (e) - 23.3 mJ

## Question 608

25-10  
0.42-34%

An electric dipole is placed perpendicular to a uniform electric field of magnitude  $1 \times 10^5$  N/C. How much work must be applied by an external agent in order to align the dipole opposite to the field? For the dipole:  $q = 1$  micro-Coulomb and  $d = 2$  mm.

- (a) - 0.1 mJ
- (b) + 0.1 mJ
- (c) + 0.4 mJ
- (d) + 0.2 mJ
- (e) - 0.4 mJ

## Question 609

25-10  
0.55-53%

Two positive charges, each of magnitude  $Q$ , are fixed at two corners of an equilateral triangle (see figure 5). The work required, by an external agent, to move a third positive charge  $q$  from  $A$  to  $C$  is:

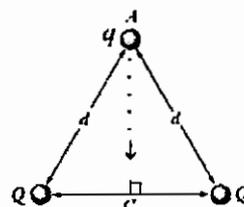


Figure 5

- (a) zero
- (b) +  $kQq/d$
- (c) -  $2kQq/d$
- (d) -  $kQq/d$
- (e) +  $2kQq/d$

## Question 610

25-10  
0.39-55%

Two balls with charges 5.0 micro-C and 10 micro-C are at a distance of 1.0 m from each other. In order to reduce the distance between them to 0.5 m the amount of work to be performed is:

- (a) 0.45 J.
- (b)  $4.5 \times 10^{(-4)}$  J.
- (c) 45.0 J.
- (d)  $1.2 \times 10^{(-4)}$  J.
- (e) 0.23 J.

## Question 611

25-10  
0.47-59%

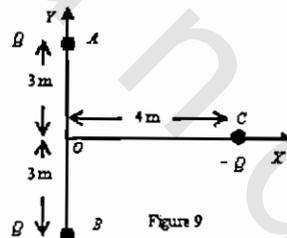
Three point charges are initially infinitely far apart. Two of the point charges are identical and have charge  $Q$ . If zero net work is required to assemble the three charges at the corners of an equilateral triangle of side  $d$ , then the value of the third charge is

- (a)  $-2 \cdot Q$ .
- (b)  $Q/2$ .
- (c)  $-Q/2$ .
- (d)  $-Q/3$ .
- (e)  $Q/3$ .

## Question 612

25-10  
0.50-66%

In figure 9, two equal positive charges, each of magnitude  $5.0 \times 10^{(-5)}$  C, are fixed at point A and B separated by a distance of 6 m. An equal and opposite charge moves towards them along the line CO. At point C, 4.0 m from O, the kinetic energy of the moving charge is 4.0 J. What is the kinetic energy of this charge when it passes point O?



- (a) 4.3 J.
- (b) 10.0 J.
- (c) 2.2 J.
- (d) 19.0 J.
- (e) 12.5 J.

## Question 613

25-10  
0.53-57%

In figure 4:  $q_1 = +1.0$  micro-Coulomb,  $q_2 = -1.0$  micro-Coulomb,  $d = 1.0$  mm and the particles were initially at rest. Particle 1 is fixed in position but particle 2 is free to move. Particle 2, with a mass of 0.010 g, is now released. What is its speed when its distance from particle 1 is  $d/2$ ?

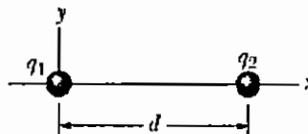


FIGURE 4

- (a)  $1.3 \times 10^{(3)}$  m/s
- (b)  $2.6 \times 10^{(3)}$  m/s
- (c)  $3.9 \times 10^{(3)}$  m/s
- (d)  $5.2 \times 10^{(3)}$  m/s
- (e)  $6.5 \times 10^{(3)}$  m/s

Question 61425-10  
0.32-67%

An electron and a proton are a distance of 1.5 nano-meter apart. How much work is required by an external agent to double the distance between the two particles? (The particles are at rest before and after the move.)

- (a)  $+2.3 \cdot 10^{(-19)}$  J
- (b)  $-2.3 \cdot 10^{(-19)}$  J
- (c)  $-3.1 \cdot 10^{(-19)}$  J
- (d)  $+7.7 \cdot 10^{(-20)}$  J
- (e)  $-7.7 \cdot 10^{(-20)}$  J

Question 61525-10  
0.48-69%

An electron is shot directly toward the center of a large metal plate that has excess negative charge with surface charge density  $2.0 \cdot 10^{(-6)}$  C/m<sup>2</sup>. If the initial kinetic energy of the electron is  $1.6 \cdot 10^{(-13)}$  J and if the electron is to stop (owing to electrostatic repulsion from the plate) just as it reaches the plate, how far from the plate must it be shot?

- (a) 4.4 m.
- (b) 8.0 m.
- (c) 22 m.
- (d) 3.4 m.
- (e) 1.2 m.

Question 61625-10  
0.33-62%

In the  $xy$  plane, a charge  $q_1 = 3.0$  micro-C located at (3.0 cm, 0.0) and another charge  $q_2 = -4.0$  micro-C located at (0.0 cm, 4.0 cm). How much work must be done, by an external agent, to bring these charges to their fixed positions starting from infinite separation. [Consider  $V = 0$  at infinity]

- (a) -2.2 J.
- (b) 3.5 J.
- (c) 1.5 J.
- (d) -3.5 J.
- (e) 2.2 J.

Question 61725-10  
0.31-75%

It is required 1.0 mJ of work to move two identical positive charges  $+q$  from infinite separation so that they are separated by a distance  $a$ . How much work is required to move four identical positive charges  $+q$  from infinite separation so that they are arranged at the corner of a square with edge length  $a$ ? [Consider  $V = 0$  at infinity]

- (a) 6.5 mJ.
- (b) 5.4 mJ.
- (c) 2.0 mJ.
- (d) 4.0 mJ.
- (e) 3.5 mJ.

Question 61825-10  
0.38-51%

Two small charges ( $q_1 = 1.0 \cdot 10^{(-8)}$  C and  $q_2 = -4.0 \cdot 10^{(-8)}$  C) move from an initial separation of 0.02 m to a final separation of 0.01 m. The change in their electrical potential energy is

- (a)  $-2.7 \cdot 10^{(-4)}$  J.
- (b)  $1.8 \cdot 10^{(-4)}$  J.
- (c)  $-3.2 \cdot 10^{(-4)}$  J.
- (d)  $-1.8 \cdot 10^{(-4)}$  J.
- (e)  $3.2 \cdot 10^{(-4)}$  J.