**Potential and work**

**A. Electrostatics - Each grid line is a meter. Charge A is +14.4 x 10-6 C, and charge B is -23.1 x 10-6 C. Find the electric field at the origin. Draw the vector as an arrow with its tail on the origin, and label the angle you calculated. Carry at least 4 sig figs for your calculations.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  | **y** |  |  |  |  |  |  |
|  |  |  |  | **A** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  | **Q** |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | **B** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | **x** |
|  | **P** |  |  |  |  |  |  |  |  |  |  |  |  |
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1. Find the Electric field vector at the origin. Fill this in:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **magnitude** | **trig. angle**  | **x-comp** | **y-comp** |
| EA |  |  |  |  |
| EB |  |  |  |  |
|  |  | EA + EB |  |  |
|  |  |  | Magnitude | Trig Angle |
|  |  |  |  |  |

2. What is the electric potential at location P? What is the electric potential at location Q? What is the potential at the origin?

3. If I were to move 6.71x10-6 C of charge from Q to P, how much work would I have to do?

4. If I move 6.71x10-6 C from Q to the origin, what work do I do? Then move it from the origin to point P – How much work is that? How does the total of both moves compare to the answer in 3.?

Answers to A

1:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | q | x | y | mag | trig angle |
| A | 1.44E-05 | -3 | 5 | 3807.53 | 300.96 |
| B | -2.31E-05 | 6 | 3 | 4614.87 | 26.57 |
|  |  |  |  |  |  |
| Ea | EA | 1958.96 | -3264.9 |  |  |
|  | EB | 4127.66 | 2063.83 |  |  |
|  | EA + EB | **6086.62** | **-1201.10** | **N/C** |  |
|  |  | mag | Trig Angle |  |  |
|  |  | **6204** | **348.84** |  |  |

2 and 3:

|  |  |  |
| --- | --- | --- |
| 2. Vp | 2.88E+03 | V |
|  Vq | -7.46E+04 | V |
| origin | -8.76E+03 | V |
| 3. Wqp | 5.20E-01 | J |

|  |  |  |
| --- | --- | --- |
| 4. Wq-origin | 4.42E-01 | J |
|  Worigin-p | 7.81E-02 | J |

 It adds up to the same thing (0.520 J) – it doesn’t matter how you get from Q to P.**B. Gravity - Each grid line is a meter. Mass A is 6.56 x 1012 kg, and mass B is 4.81 x 1012 kg. Find the gravitational field at the origin. Draw the vector as an arrow with its tail on the origin, and label the angle you calculated. Carry at least 4 sig figs for your calculations.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  | **y** |  |  |  |  |  |  |
|  |  |  | **Q** |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  | **P** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  | **B** |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | **x** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  | **A** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. Find the gravitational field vector at the origin. Fill in this table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **magnitude** | **trig. angle**  | **x-comp** | **y-comp** |
| gA |  |  |  |  |
| gB |  |  |  |  |
|  |  | gA + gB |  |  |
|  |  |  | Magnitude | Trig Angle |
|  |  |  |  |  |

2. What is the gravitational potential at location P? What is the gravitational potential at location Q? What is the potential at the origin?

3. If I were to move 72.5 kg of mass from Q to P, how much work would I have to do?

4. If I move 72.5 kg from Q to the origin, what work do I do? Then move it from the origin to point P – How much work is that? How does the total of both moves compare to the answer in 3.?

Answers to B

1:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | m | x | y | mag | trig angle |
| A | 6.56E+12 | -2 | -5 | 15.09 | 248.20 |
| B | 4.81E+12 | 4 | 1 | 18.87 | 14.04 |
|  |  | x | y |  |  |
|  | Ea | -5.60354 | -14.009 |  |  |
|  | Eb | 18.3087 | 4.57718 |  |  |
|  |  | **12.71** | **-9.43** | **N/C** |  |
|  |  | mag | angle |  |  |
|  |  | **15.8233** | **323.412** |  |  |

2-4:

|  |  |  |
| --- | --- | --- |
| 2. Vp | -184.64 | J/kg |
|  Vq | -78.78 | J/kg |
| Vo  | -159.06 |  |
| 3. Wqp | -7.68E+03 | J |
| 4. Wq-o | -5.82E+03 | J |
| Wo-p | -1.85E+03 | J |
| Total | -7.68E+03 | J |

The total is the same - It doesn’t matter how you go from Q to P, the net work is the same.