B4 · Extra practice

Worked solutions | Items 1-2

Extra practice for this lesson. Original questions, not released diploma items. Select one option for multiple choice; other tasks state the required response.

Use $k = 8.99 \times 10^9$ N·m²/C² and $g = 9.81$ m/s² where needed (Alberta Physics 30 data sheets, Constants). For numerical responses, use the stated unit or coefficient and precision. Work in degrees.

B4-D01 · Multiple choice

A fixed-source field at P points north. Which statement is correct for a small negative test charge at P?

A. Its force points south; the source field still points north.

B. Its force points north; the source field points south.

C. Both force and field point south.

D. No force acts because the test charge is negative.

1. Field direction is defined by a positive test charge. F = qE reverses force direction for a negative q, so the force is south.

2. Changing a small test charge does not reverse the field of the source. B mixes up the direction rule; C reverses the field; D wrongly removes the force.

3. Answer: A.

B4-D02 · Multiple choice

At the midpoint between equal opposite source charges, with positive on the left and negative on the right, the net field is:

A. zero because the charges sum to zero.

B. left because the negative source is on the right.

C. right because both field contributions point right.

D. up because two sources are present.

1. The field from the positive source points away from it, right at the midpoint. The field from the negative source points toward it, also right.

2. Their magnitudes add. A adds charges before considering geometry; B reverses the negative-source field; D invents a direction unrelated to the sources.

3. Answer: C.

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Worked solutions | Items 3-4

B4-D03 · Multiple choice

Parallel equally spaced field arrows point down between large horizontal plates. Which statement is correct?

A. Upper negative; electron force down.

B. Upper positive; electron force down.

C. Upper negative; electron force up.

D. Upper positive; electron force up.

1. Field goes from positive to negative, so the upper plate is positive. An electron is negative, so its force opposes the downward field and points up.

2. A gets both signs and force wrong. B treats the electron like a positive test charge; C reverses the plate signs.

3. Answer: D.

B4-D04 · Multiple choice

A point source’s charge is fixed. If source-to-point distance triples, what is the new field strength?

A. 3E

B. E/9

C. E/3

D. 9E

1. For a point source, $E = k|Q|/r^2$. With Q fixed, tripling distance makes the denominator nine times larger: Enew = E/9.

2. A and D predict increasing strength farther away. C uses inverse distance rather than inverse-square distance.

3. Answer: B.

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Worked solutions | Items 5-6

B4-D05 · Numerical response

A +3.00 μC test charge feels 0.0600 N right. What is field strength, expressed as a × 10^4 N/C? Record a to three significant figures.

1. Use E = F/q because a test charge's force and charge are given. E = 0.0600/(3.00 × 10^{-6}) = 2.00 × 10^4 N/C.

2. The positive test charge indicates the field is right. The requested number a is 2.00.

3. Response: 2.00.

B4-D06 · Numerical response

A point source +2.00 μC is 0.400 m from P. Use k = 8.99 × 10^9 N·m^2/C^2. What is field strength at P, expressed as a × 10^5 N/C? Record a to three significant figures.

1. Use the source-field equation E = k|Q|/r^2. E = (8.99 × 10^9)(2.00 × 10^{-6})/0.400^2 = 1.12375 × 10^5 N/C.

2. Rounded number a = 1.12. Field direction is away from the positive source; no orientation was given for an absolute direction.

3. Response: 1.12.

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Worked solutions | Items 7-8

B4-D07 · Numerical response

A −4.00 nC test charge is in a field of 3.00×10^{4} N/C east. What is force magnitude, expressed as a $\times 10^{-4}$ N? Record a to three significant figures.

1. The field is already known, so use $|F| = |q|E = (4.00 \times 10^{-9})(3.00 \times 10^{4}) = 1.20 \times 10^{-4}$ N.

2. The requested number is 1.20. The full force points west because the test charge is negative.

3. Response: 1.20.

B4-D08 · Numerical response

A +1.00 µC source lies 0.200 m left of P and a −1.00 µC source lies 0.200 m right of P. Use $k = 8.99 \times 10^{9}$ N·m²/C². What is net field strength, expressed as a $\times 10^{5}$ N/C? Record a to three significant figures.

1. At P, both fields point right: away from the positive and toward the negative. Each strength is $(8.99 \times 10^{9})(1.00 \times 10^{-6})/0.200^{2} = 2.2475 \times 10^{5}$ N/C.

2. Net strength = 4.495×10^{5} N/C, rounded to 4.50×10^{5} N/C right. Record 4.50.

3. Response: 4.50.

B4 · Extra practice

Worked solutions | Items 9-10

B4-D09 · Select all that apply

For the field of a point source, choose every true statement: A. A negative test charge’s force opposes E. B. The source field exists with no test charge. C. Doubling a small test charge doubles E. D. Electric field is a vector.

1. A follows F = qE with negative q. B expresses that the field is produced by sources. D means it has both magnitude and direction.

2. C is false: doubling the test charge doubles its force, while E = F/q stays unchanged at that point.

3. Answer: A, B and D.

B4-D10 · Matching

Match each source or region to its field drawing. 1 = arrows straight out; 2 = arrows straight in; 3 = parallel equally spaced arrows. Cases: (a) negative point source; (b) uniform field between plates; (c) positive point source. Record a-b-c codes.

1. Field points toward negative sources, so (a) is 2. An ideal uniform field has constant strength and direction, so (b) is 3.

2. Field points away from positive sources, so (c) is 1. The code is 231. Arrows show positive-test charge force direction, not every particle’s path.

3. Answer: 231.

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Worked solutions | Items 11-12

B4-D11 · Ranking

The same source creates field E at distance r. Points A, B and C are at distances r, 2r and r/2. Rank their field strengths largest to smallest. Does the sign of the source change this ranking?

1. Strengths are E, E/4 and 4E respectively, from the inverse-square law. Thus C > A > B.

2. Changing source sign reverses toward/away direction but leaves |Q| unchanged, so it does not change the strength ranking.

3. Answer: C > A > B; no.

B4-D12 · Source-based reasoning

A field map gives 8.00×10^4 N/C at 0.100 m and 2.00×10^4 N/C at 0.200 m from one fixed source. What relationship fits these values? Would these two values alone prove the law? Explain.

1. Doubling distance reduces strength to one quarter: 2.00/8.00 = 1/4. That agrees with E proportional to $1/r^2$ for a fixed point source.

2. A simulator programmed with point-charge equations returns those equations' predictions. It checks a prediction within the model, but is not independent experimental evidence of the physical law.

3. Answer: Inverse square; no.