

Charging objects and the force between charges

AP Physics 2 (algebra-based) · Lab

Name: _____ Date: _____ Class: _____

How does the electric force between two like charges change as they are brought closer together? In this lab a balance measures the downward push of one charged sphere on another, and you use the readings to test the inverse-square law and to find the charge carried by each sphere.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 10

Aim

To measure how the repulsive force between two like-charged spheres depends on their separation, and to find the charge on each sphere.

Equipment

- Top-pan balance reading to 0.001 g
- Two identical conducting spheres on insulating mounts, one resting on the pan and one on a rod above it
- Low-current high-voltage supply with protective resistor, or a Van de Graaff generator with a charging wand
- Ruler or metre rule and a retort stand
- Dry cloth and a dehumidified room if possible

Safety

Safety

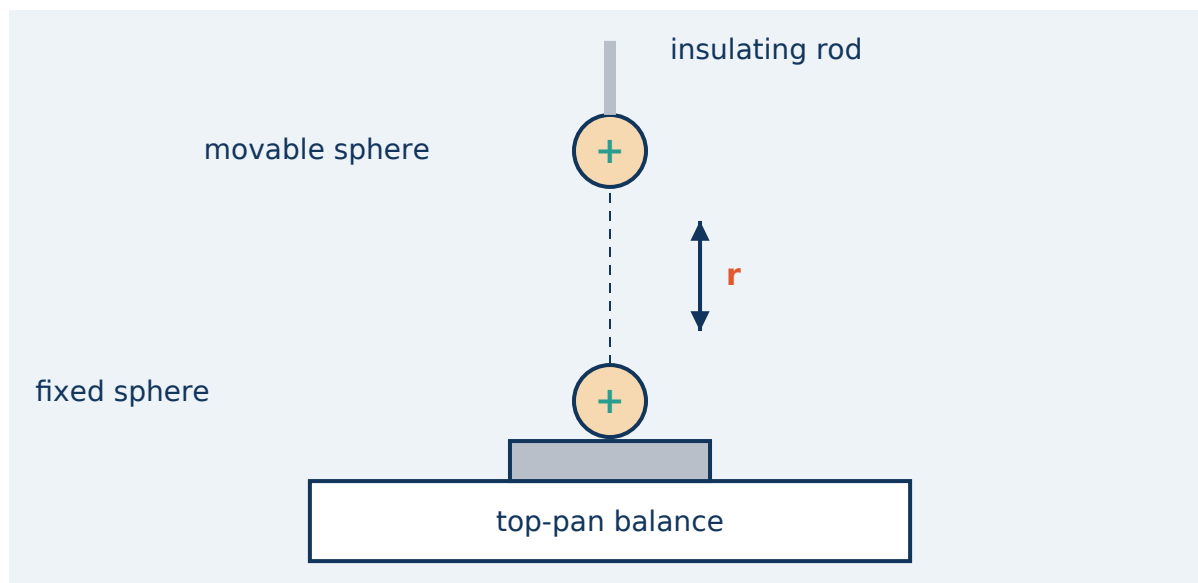
Use only a supply with a protective resistor of at least 5 M Ω and never touch the terminals. Anyone with a heart condition or pacemaker must not take part. Discharge the spheres by touching them with an earthed lead before handling.

Method

1. Place the lower sphere on the balance pan and tare the balance to zero.
2. Charge both spheres equally by touching each to the same terminal, then isolate them.
3. Hold the upper sphere above the lower one at $r = 8.0$ cm between centres. Record the

balance reading Δm .

4. Reduce r in steps to 6.0, 5.0, 4.0 and 3.0 cm, recharging when the readings drift.
5. Calculate $F = \Delta m g$ and $1/r^2$ for each distance.



The upper sphere pushes the lower one down, so the balance reading rises as r gets smaller.

Results

Sample readings from Diego's class in Texas are shown. Fill in the last two columns yourself.

r (cm)	Δm (g)	F (N)	$1/r^2$ (m^{-2})
8.0	0.058		
6.0	0.101		
5.0	0.149		
4.0	0.228		
3.0	0.405		

Analysis questions

Question 1 Convert to force

Use $g = 9.81 \text{ m/s}^2$ to calculate F for the readings at $r = 3.0 \text{ cm}$ and $r = 8.0 \text{ cm}$.

Question 2 Calculate $1/r^2$

Convert each separation to metres and calculate $1/r^2$ for all five readings.

Question 3 Plot and describe

Plot F against $1/r^2$ and describe the graph.

Question 4 Gradient

Find the gradient using the 3.0 cm point and give its unit and meaning.

Question 5 Charge on a sphere

Use the gradient to calculate the charge on each sphere.

Question 6 Testing the power law

Use the 3.0 cm and 8.0 cm readings to find the exponent n in $F \propto 1/r^n$.

Question 7 Sources of error

Suggest two sources of error and say how each would change the readings.