1. (0 Points) What course is this?
   a. PHYS 1401   b. PHYS 1402   c. PHYS 2425   d. PHYS 2426
2. (0 Points) What exam is this?
   a. Exam 1   b. Exam 2   c. Final Exam
3. (0 Points) What version of the exam is this?
   a. Version A   b. Version B   c. Version C   d. Version D
4. In the figure to the right, the red arrows indicate the direction of the electric field. Determine the signs of each of the three charges.
   a. All three charges are positive.
   b. All three charges are negative.
   c. A is negative, while B and C are positive.
   d. A is positive, while B and C are negative.
   e. A and B are positive, while C is negative.
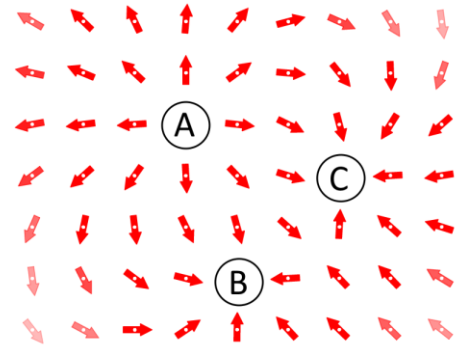
(Questions 5–7) A charge of 4.0 nC is at the origin. There are no other charges in the universe.

Consider a point P located 1.5 m away, along the $+x$ axis.
5. What is the direction of the electric field at point P?
   a. $+x$
   b. $-x$
   c. $+y$
   d. $-y$
   e. It is zero.
6. What is the magnitude of the electric field at point P?
   a. 2.6 N/C
   b. 6 N/C
   c. 16 N/C
   d. 24 N/C
   e. 64 N/C
7. If a $(-5.0$ nC) charge is now placed at point P, what is the direction of the force on this new charge?
   a. $+x$
   b. $-x$
   c. $+y$
   d. $-y$
   e. It is zero.

8. A balloon is rubbed against a cotton or wool shirt, and the balloon becomes negatively charged. What is the most likely physical change that occurred to caused this charge?
   a. Some of the balloon's electrons were destroyed.
   b. The rubbing process created some extra electrons.
   c. The balloon lost some electrons to the shirt.
   d. The balloon picked up some extra electrons from the shirt.
   e. The balloon lost some protons to the shirt.

9. In the figure to the right, two points, A and B, are located within a region in which an electric field points toward the right. How would you describe the relationship between their electric potentials V_A and V_B?
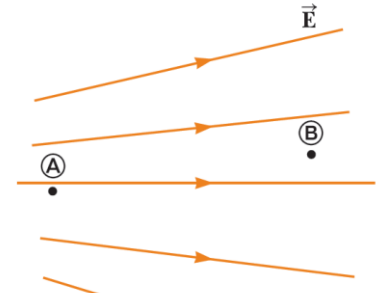
   a. V_A is a higher potential.
   b. V_B is a higher potential.
   c. The points are at the same potential.
   d. It depends on what kind of charge is placed in the region.
   e. Impossible to determine from the information given.

10. How many protons does it take to form a coulomb of charge?

    a. 6.25×10^{18} protons
    b. 1.6×10^{-19} protons
    c. 9.1×10^{-31} protons
    d. 1.6×10^{18} protons
    e. 1.1×10^{30} protons

11. A 0.5 F capacitor is charged up to a potential difference of 10 V. What is the charge of just the positive plate of the capacitor?

    a. 0.05 C
    b. 5.0 C
    c. 10.0 C
    d. 20.0 C
    e. 0.0 C

12. A 0.5 F capacitor is charged up to a potential difference of 10 V. What is the total charge of the capacitor, including both plates?

    a. 0.05 C
    b. 5.0 C
    c. 10.0 C
    d. 20.0 C
    e. 0.0 C

13. In an RC circuit, when a capacitor is fully charged, the current passing through the resistor is…

    a. zero.
    b. at its maximum value.
    c. equal to half of its maximum value.

14. In a working electrical circuit, the electric current has this behavior:

    a. It is emitted by the battery and absorbed by the load.
    b. It is emitted by the load and absorbed by the battery.
    c. It flows in the air around the wires, in a direction determined by the right-hand rule.
    d. It circulates around the circuit like blood flowing around our cardiovascular system.

    (Note: The "load" is the device using the electricity, such as a light bulb, motor, or resistor.)
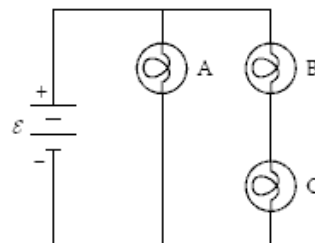
15. If an electron beam is pointed northward, what is the direction of the electric current formed by the beam?

    a. North
    b. South
    c. Upward
    d. Downward
    e. Clockwise, as viewed from the top.

16. If a circuit consists of an ideal battery, an appropriate light bulb, and an ideal voltmeter, all in series,
    a. The bulb will be lit, but the voltmeter will display zero.
    b. The bulb will be lit, and the voltmeter will display half of the battery's EMF.
    c. The bulb will be lit, and the voltmeter will display the battery's EMF.
    d. The bulb will be off, and the voltmeter will display zero.
    e. The bulb will be off, and the voltmeter will display the battery's EMF.

17. A cylindrical wire has a radius r and a length ℓ. If ℓ and r are both doubled, the resistance of the wire...
    a. Increases.
    b. Decreases.
    c. Remains the same.
    d. It depends on which of r and ℓ is larger.
    e. Becomes negative.

18. A 7.0 Ω resistor is connected to a 5.0 V adjustable power supply. If the voltage is doubled, what happens to the resistance?
    a. The resistance increases 4×.
    b. The resistance doubles.
    c. The resistance stays the same.
    d. The resistance is cut in half.
    e. The resistance decreases 4×.

(Questions 19 and 20) A proton is levitated using only an electric field.

19. What electric field strength is required to support the weight of the proton?
    a. 1.6×10^{-19} N/C
    b. 5.6×10^{-11} N/C
    c. 1.02×10^{-7} N/C
    d. 9.4×10^{8} N/C
    e. 9.8×10^{6} N/C

20. What is the direction of the required electric field?
    a. North
    b. South
    c. Up
    d. Down
    e. Away from the proton.

21. A light bulb that uses LED technology currently costs $8. Using it reduces electric power usage by about 50 W. If electricity costs $0.12/kWh, how long would it take (in continuous operation) to recoup the costs of buying the bulb? (Reminders: 1 kWh = 1 kW × 1 hour, 1 day = 24 hours)
    a. 1 week (approx. 7 days)
    b. 1 month (approx. 30 days)
    c. 2 months (approx. 60 days)
    d. 1 year (approx. 365 days)
    e. 2 years (approx. 730 days)

22. In the circuit to the right, which bulb is the brightest?
    a. A
    b. B
    c. C
    d. B and C
    e. All three are equally bright.

23. A cheap USB charging cable only has 28 AWG wires. (28 AWG wire has a cross-sectional area of 0.0810 mm² and copper has a resistivity of 1.7×10⁻⁸ Ω m.) If you are charging a tablet with 2.0 A of current, how much voltage is lost in a 2.0 m length of this cheap wire?
    a. 0.0008 V
    b. 0.1 V
    c. 0.4 V
    d. 0.8 V
    e. 2 V

24. In an RC circuit, how many time constants must elapse if an initially charged capacitor to reach 50% of its initial voltage?
    a. 0.5
    b. 0.6
    c. 0.7
    d. 1.0
    e. 1.6

25. A cell phone which is 7 cm × 14 cm is placed on a metal table. There is a metal plate in the entire back of the phone which is now 1 mm away from the table. If this system acts like a parallel-plate capacitor with a dielectric constant of 1, what is the capacitance between the phone and the table? (Note: 1 pF = 10⁻¹² F)
    a. 8.7 pF
    b. 87 pF
    c. 8.7 nF
    d. 87 nF
    e. 8.7 μF

26. How much electric flux is generated by a single proton? (Volt-meter (V·m) is the SI unit of electric flux.)
    a. 1.6×10^{-19} V·m
    b. 8.85×10^{-12} V·m
    c. 1.8×10^{-8} V·m
    d. 1.0 V·m
    e. 5.5×10^{7} V·m

27. If a 10 Ω, a 15 Ω, and a 30 Ω resistor are placed in parallel, what is their combined equivalent resistance?
    a. 0.2 Ω
    b. 5 Ω
    c. 15 Ω
    d. 20 Ω
    e. 55 Ω

28. Which of the following statements about the electric field of a single isolated charge is not correct?
    a. The magnitude of the field depends on the distance from the charge.
    b. The magnitude of the field depends on the magnitude of the charge.
    c. The magnitude of the field depends on the sign of the charge.
    d. The direction of the field depends on the position relative to the charge.
    e. The direction of the field depends on the sign of the charge.

Kirchoff's Laws
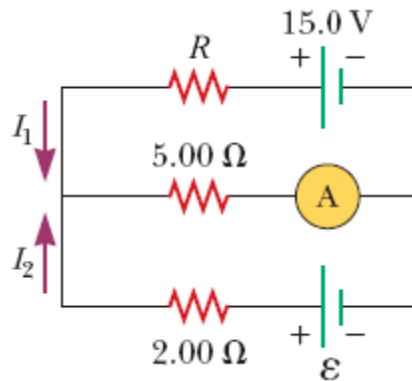
In the figure above, $R = 6.75\ \Omega$ and the ammeter reads 1.85 A.

(In this section, as always, choose the closest answer.)

29. What is the current I_2 in the lower branch of the circuit?
   a.   0.1 A
   b.   0.4 A
   c.   0.7 A
   d.   1.0 A
   e.   1.3 A

30. What is the voltage ε of the unknown battery?
   a.   7 V
   b.   11 V
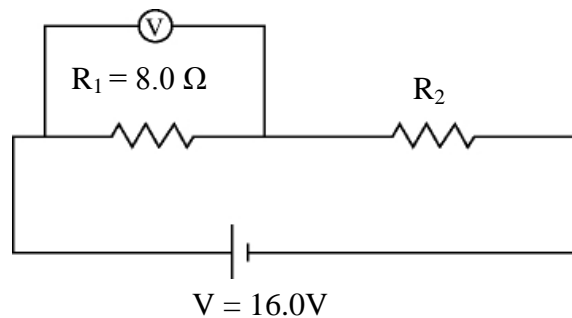   c.   15 V
   d.   19 V
   e.   23 V

31. In the circuit to the right, the voltmeter reads 4.0 V. What is the voltage across R_2?
   a.   0.0 V
   b.   4.0 V
   c.   8.0 V
   d.   12.0 V
   e.   16.0 V

32. In the circuit to the right, what is the current passing through R_1?
   a.   0.0 A
   b.   0.5 A
   c.   0.86 A
   d.   1.2 A
   e.   2.0 A

33. In the circuit to the right, what is the value of R_2?
   a.   6.0 Ω
   b.   8.0 Ω
   c.   12 Ω
   d.   24 Ω
   e.   32 Ω