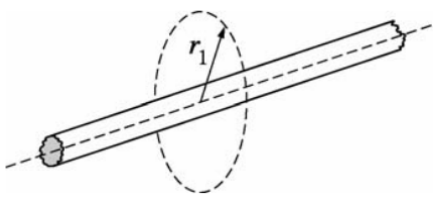
PHYSICS C: ELECTRICITY AND MAGNETISM
Section I
Time–45 minutes
35 Questions

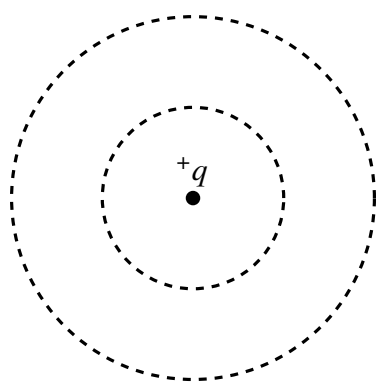
Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and place the letter of your choice in the corresponding box on the student answer sheet.

1. Two negative point charges are a distance x apart and have potential energy U. If the distance between the point charges increases to $3x$, what is their new potential energy?
   (A) $9U$
   (B) $3U$
   (C) U
   (D) $U/3$
   (E) $U/9$



2. An electric field is produced by the very long, uniformly charged rod drawn above. If the strength of the electric field is E_1 at a distance r_1 from the axis of the rod, at what distance from the axis is the field strength $\frac{E_1}{4}$?
   (A) $\frac{r_1}{4}$
   (B) $\frac{r_1}{2}$
   (C) $2r_1$
   (D) $4r_1$
   (E) $16r_1$

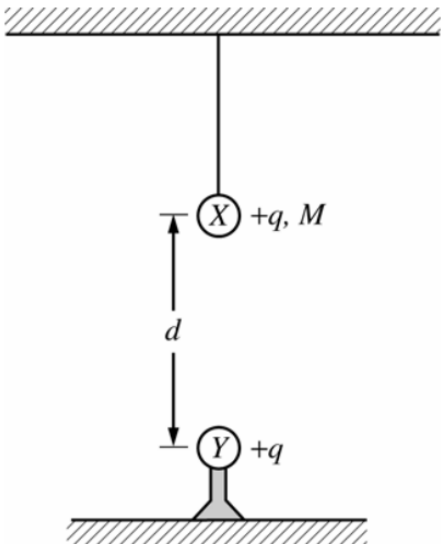
Question 3–4



Two concentric spherical surfaces are drawn around an isolated positive charge $+q$ located at their center, as shown above. The inner surface has a radius that is $1/2$ that of the outer surface.

3. If the total electric flux passing through the inner surface is ϕ, what is the total electric flux passing through the outer surface?
   (A) $\phi/4$
   (B) $\phi/2$
   (C) ϕ
   (D) 2ϕ
   (E) 4ϕ

4. If the electric field strength at the inner surface is E, what is the electric field strength at the outer surface?
   (A) $E/4$
   (B) $E/2$
   (C) E
   (D) $2E$
   (E) $4E$



5. Sphere X of mass M and charge $+q$ hangs from a string as shown above. Sphere Y has an equal charge $+q$ and is fixed in place a distance d directly below sphere X. If sphere X is in equilibrium, the tension in the string is most nearly

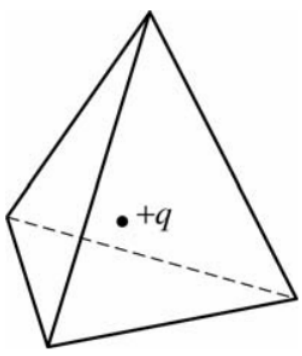
(A) Mg

(B) $Mg + \frac{kq}{d}$

(C) $Mg - \frac{kq}{d}$

(D) $Mg + \frac{kq^2}{d^2}$

(E) $Mg - \frac{kq^2}{d^2}$



6. A charge $+q$ is placed at the center of a tetrahedron whose faces are all equilateral triangles, as shown above. What is the flux of the electric field through one face of the tetrahedron?

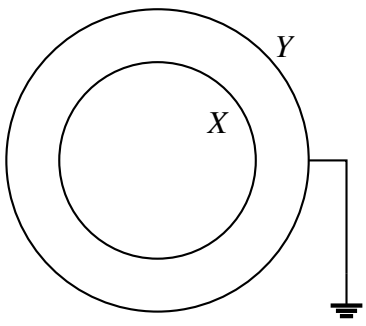
(A) 0

(B) $\frac{q}{\epsilon_0}$

(C) $\frac{q}{4\epsilon_0}$

(D) $4\epsilon_0 q$

(E) The flux through one face cannot be determined from the information given.



7. Two concentric metal spheres X and Y are shown above. X carries a positive charge, and Y is connected to ground. True statements include which of the following?

I. The electric field inside X is zero.

II. The electric field outside Y is zero.

III. The charge density on both spheres is the same.

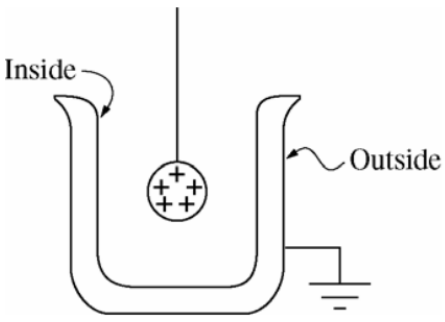
(A) I only

(B) III only

(C) I and II only

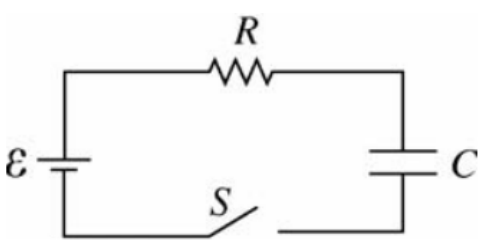
(D) II and III only

(E) I, II, and III

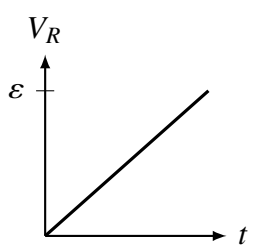


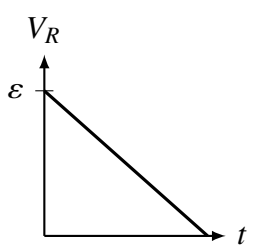
8. A small positively charged sphere is lowered by a nonconducting thread into a grounded metal cup without touching the inside surface of the cup, as shown above. The grounding wire attached to the outside surface is disconnected and the charged sphere is then removed from the cup. Which of the following best describes the subsequent distribution of excess charge on the surface of the cup?

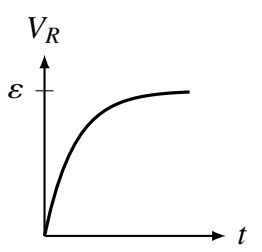
(A) Negative charge resides on the inside surface, and no charge resides on the outside surface.
(B) Negative charge resides on the outside surface, and no charge resides on the inside surface.
(C) Positive charge resides on the inside surface, and no charge resides on the outside surface.
(D) Positive charge resides on the outside surface, and no charge resides on the inside surface.
(E) Negative charge resides on the inside surface, and positive charge resides on the outside surface.

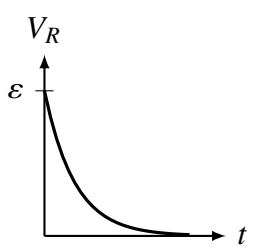


9. The capacitor C in the circuit shown above is initially uncharged. The switch S is then closed. Which of the following best represents the voltage V_R across the resistor R as a function of time t?

(A) 

(B) 

(C) 

(D) 

(E)