

Exam 2

Physics 1320, March 28, 2022

The exam consists of 20 questions. Two are bonus, so you will be scored out of 18, so it is possible to get a score of 20/18=111%

The exam is closed-book and closed-notes. You may use your own calculator, but you may not store formula on your calculator.

Useful Information

mass of proton: $1.67 \times 10^{-27} \text{ kg}$

mass of electron: $9.1 \times 10^{-31} \text{ kg}$

$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$

$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$

proton's charge: $e = 1.6 \times 10^{-19} \text{ C}$

electron's charge: $-e$

The prefix n means "nano" and stands for 10^{-9} .

The prefix μ means "micro" and stands for 10^{-6} .

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enclosed}}}{\epsilon_0}$$

1)

What is the magnitude of the repulsive force between two ions, one having a charge of $2e$, and the other having a charge of $3e$, if they are separated from one another by a distance of 2 nm ?

(a) $0.6\text{E-}10 \text{ N}$

(b) $1.4\text{E-}10 \text{ N}$

(c) $2.1\text{E-}10 \text{ N}$

(d) $3.5\text{E-}10\text{N}$

Answer: d

2)

What is the change in electrical potential energy when an electron and proton initially separated from one another by 2.11×10^{-10} meters move closer together to a final separation distance of 0.529×10^{-10} meters? (Note: $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$)

- (a) -18.6 eV
- (b) -20.4 eV
- (c) -24.2 eV
- (d) -27.2 eV

Answer: b

3)

A charge of 1 nC is transferred to neutral metal sphere having a radius 10 cm . What is the strength of the electric field at a point outside the sphere, just above the surface of the sphere?

- (a) 900 N/C .
- (b) 400 N/C .
- (c) 225 N/C .
- (d) 144 N/C .

Answer: a

4)

Consider two concentric spherical shells, an inner shell with radius 10 cm , and an outer shell with radius 20 cm . The inner shell has a positive uniform surface charge density 1.00 nC/m^2 . The outer shell has a negative uniform surface charge density -1.00 nC/m^2 . What is the electric field at a point outside both shells, at a radial distance 25 cm from their common center?

- (a) 54.2 N/C
- (b) -54.2 N/C
- (c) 50.3 N/C
- (d) -50.3 N/C

Answer: b

5)

When a charge of 4.8×10^{-6} Coulombs is transferred to the surface of the spherical globe of a Van de Graaff generator, the electric field at the surface reaches the breakdown threshold for dry air of 3×10^6 N/C . What is the radius of the globe?

(a) 18 cm

(b) 16 cm

(c) 14 cm

(d) 12 cm

Answer: d

6)

If the potential drop is 10 volts across a resistor carrying a current of 4 amps, what is the resistance?

(a) 7.5

(b) 6.5

(c) 2.5

(d) 1.5

Answer: c

7)

An infinite sheet of charge has a uniform surface charge density of $1 \mu\text{C}/\text{m}^2$. An infinite wire has a uniform linear charge density of $-1 \mu\text{C}/\text{m}$. The wire is parallel to the plane, separated from the plane by 1 meter. For every 1 meter of wire, what is the strength of the attractive force between the surface and the wire?

(a) 0.33 N/m

(b) 0.22 N/m

(c) 0.11 N/m

(d) 0.056 N/m

Answer: d

8)

A parallel plate capacitor consists of two closely-spaced parallel plates that are uniformly charged; one is positive and other other is negative. Suppose that the plates are separated from one another by a vacuum gap of $10 \mu\text{m}$, and have surface charge densities $\pm 5 \text{ nC} / \text{m}^2$ respectively. If an electron breaks free from the negative plate (the cathode) and accelerates across the gap under the influence of the electric field, how much kinetic energy will it have gained when it strikes the positive plate (the anode)?

(a) 2.8 meV ($4.5\text{E-}22$ J)

(b) 3.7 meV ($6.0\text{E-}22$ J)

(c) 5.6 meV ($9.0\text{E-}22$ J)

(d) 8.4 meV ($13.5\text{E-}22$ J)

Answer: c

9)

Assuming it to be an isolated sphere, the globe on the Van de Graaff generator at Regener Hall has a capacitance of $1.7\text{E-}11$ Farads. What is the minimum amount of work required to transfer $7 \mu\text{C}$ to the globe?

(a) 0.7 J

(b) 1.4 J

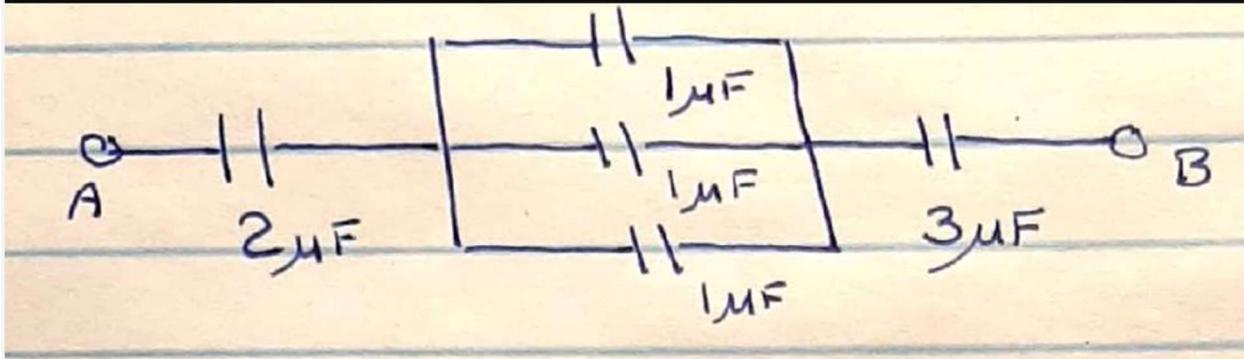
(c) 2.2 J

(d) 2.8 J

Answer: b

10)

Four capacitors are connected together in the manner shown in the figure below. The capacitance of each capacitor is indicated in micro farads. What is the equivalent capacitance between terminals A and B?



- (a) 0.52 micro farads
- (b) 0.86 micro farads
- (c) 1.53 micro farads
- (d) 2.24 micro farads

Answer: b

11)

A capacitor with capacitance of 1.0 pF has a dielectric spacer with a dielectric constant of 3.0. What would be the capacitance if instead the dielectric constant were 6.0?

- (a) 2.0 pF
- (b) 4.0 pF
- (c) 6.0 pF
- (d) 8.0 pF

Answer: a

12)

The following statements concern a metal in equilibrium. Which of the following is false?

- (a) The electric field at the surface of a metal in equilibrium must be normal to the surface.

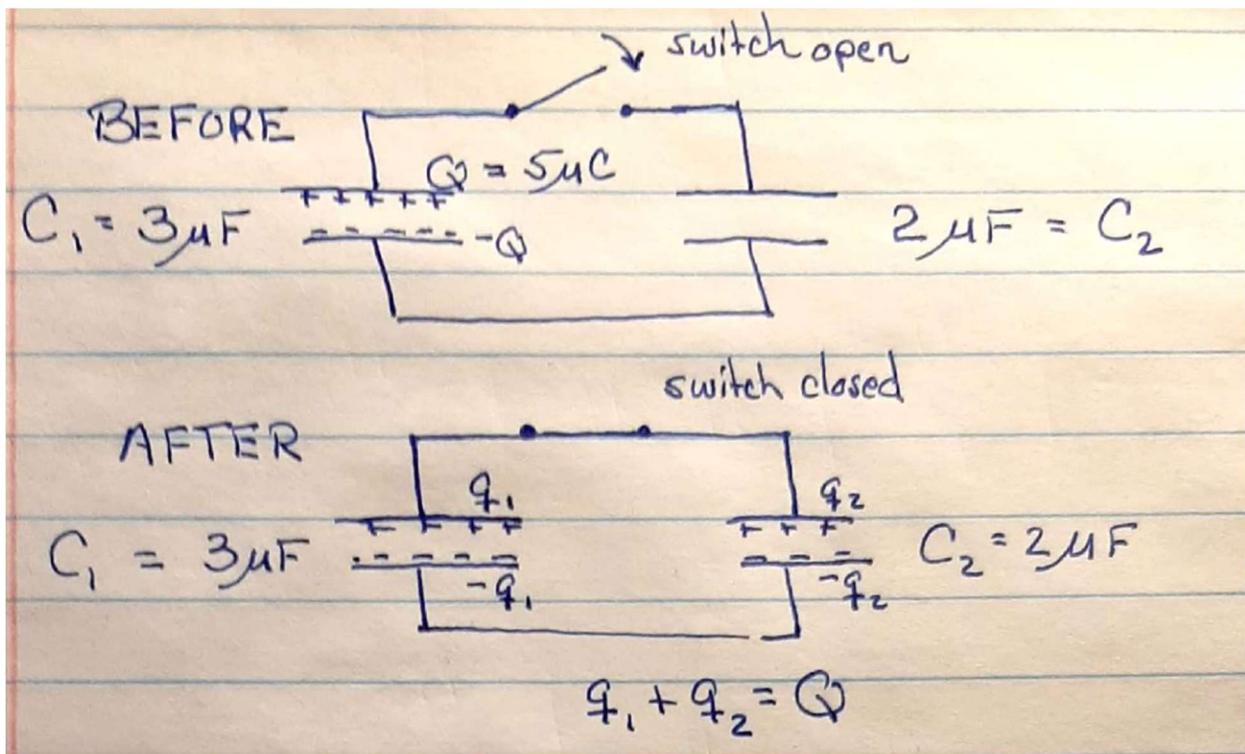
(b) In equilibrium, all points on a metal are at the same potential.

(c) Charges placed on a metal will distribute in a manner that minimizes the (free) energy.

(d) The electric field within a metal is constant.

Answer: d ~~or~~ c

13) Initially the 3 microfarad capacitor has a charge $Q=5$ microcoulombs, and the 2 microfarad capacitor is uncharged. How much charge q_2 will move from the 3 microfarad capacitor to the 2 microfarad capacitor when the switch is closed?



(a) 1 micro coulomb

(b) 2 micro coulombs

(c) 3 micro coulombs

(d) 4 micro coulombs

(e) 5 micro coulombs

Answer: b

14)

At the origin $(x,y)=(0,0)$ an electric field has magnitude of 10 N/C , and is directed along the positive x axis (\hat{i}). What is the force exerted by the field on an electron placed at the origin?

- (a) $10 \text{ N } \hat{i}$
- (b) $-1.6\text{E-}18 \text{ N } \hat{i}$
- (c) $-1.0 \text{ N } \hat{i}$
- (d) $-2.6\text{E-}19 \text{ N } \hat{i}$
- (e) $1.2\text{E-}19 \text{ N } \hat{i}$

Answer: b

15)

A parallel plate capacitor consists of two square sheets of aluminum foil with dimensions 10 cm by 10 cm , separated from one another by a sheet of wax paper having a thickness of 40 microns . The dielectric constant is 3.7 . What is the capacitance?

- (a) 2.2 nF
- (b) 5.3 nF
- (c) 8.2 nF
- (d) 9.7 nF

Answer: ~~b~~ c

16)

What is the current through a light bulb that emits 75 W radiation when placed in series with a 120 V voltage source?

- (a) 0.125 A
- (b) 0.250 A

(c) 0.550 A.

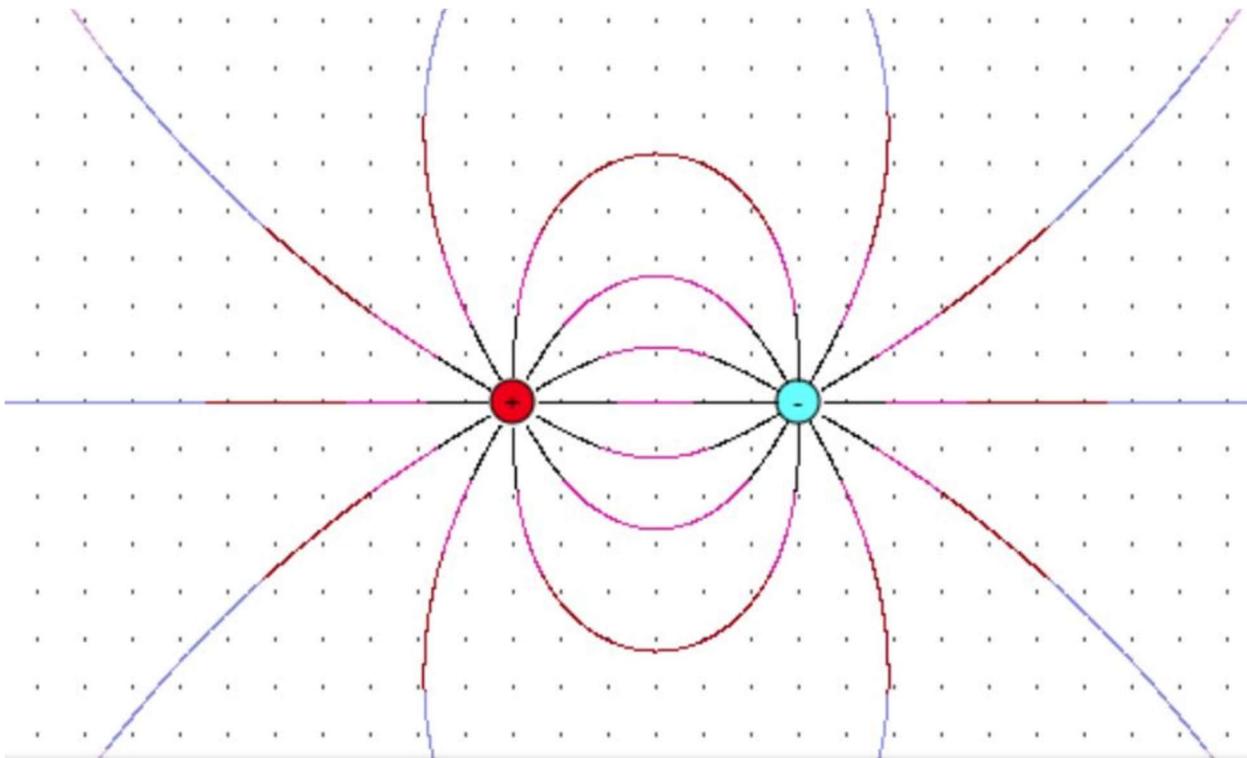
(d) 0.625 A

Answer: d

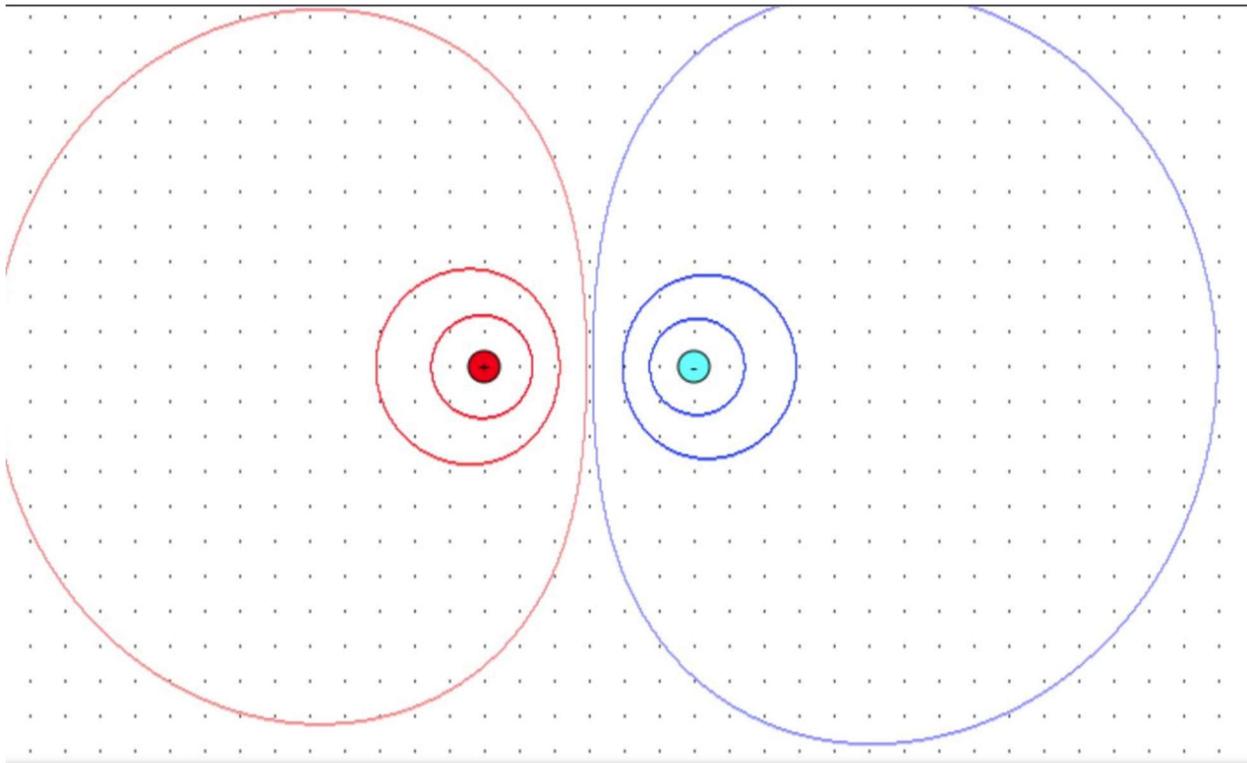
17)

One of the two graphs below is a sketch of the electric field lines of a dipole. The other is a sketch of the corresponding equipotentials. Which of the two, Graph A or Graph B, shows the equipotentials?

Graph A



Graph B



- (a) Graph A
- (b) Graph B

Answer: b

18)

What are the units of electric field?

- (a) Coulombs per volt
- (b) Volts per meter.
- (c) Coulombs per newton.
- (d) Joules per coulomb.

Answer: b

19)

What are the units of electrical current?

- (a) Coulombs per volt
- (b) Volts per meter.
- (c) Coulombs per newton.

(d) Coulombs per second

Answer: d

20)

What is the total charge that can be delivered by a battery that is rated at 350 mAh?

(a) 1300 Coulombs

(b) 900 Coulombs .

(c) 500 Coulombs

(d) 300 Coulombs

Answer: a

Version AA