YOUR NAME
AB 2vl

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Turn in scantron
You keep these question sheets

17 1)	**This is to identify the exam version you have – IMPORTANT** **Mark the A**
3 2)	**This is to identify the exam version you have – IMPORTANT** **Mark the B**
3) E	Three charges [1,2,3] are placed at the corners of an equilateral triangle as shown. The charges are equal in magnitude, but differ in sign as <u>not</u> shown. The net electrostatic potential at the center of the triangle is negative and The E-field points down ↓on the midpoint of the bottom side of the triangle [marked x]. 1 • x V⁻ 2 • x 3 • ↓E V⁻ 2 or 3 of charges negative 3: wrong E @ x 2: must balance @ x ⇒ •2, •3 negative •1 positive The charges must be: (a) 1:-, 2:-, 3:- (b) 1:+, 2:-, 3:+ (c) 1:-, 2:+, 3:- (d) 1:-, 2:-, 3:+ (e) 1:+, 2:-, 3:- 80
4) B	A positive charge is shot with velocity pointing in the ← direction into an electric field and slowing down due to the field. From this we can conclude that the electric field vector points a) ← b) → c) ↑ d) ↓ 92 e) Is zero Vi → FORCE → E

5) 2 Charges: one positive of unknown magnitude and on negative of -1 C are a distance R apart.

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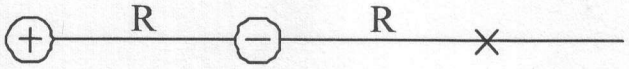
The magnitude of the positive charge is such that at a point a distance R to the right of –Q, at marker "X", the net electric field is zero.

$\vec{E}_{NET} = 0 = \vec{E}^{+} + \vec{E}^{-}$



$E^{+} = k_e \frac{q^{+}}{(2R)^2}$

$E^{-} = k_e \frac{q^{-}}{R^2}$

equal

$\Downarrow$

$|q^{+}| = 4|q^{-}|$

Then the net electric potential at that point X is :

A. Positive
B. Negative
C. Zero
D. The E-field cannot be zero at point x.

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$V_{NET} = V^{+} + V^{-}$

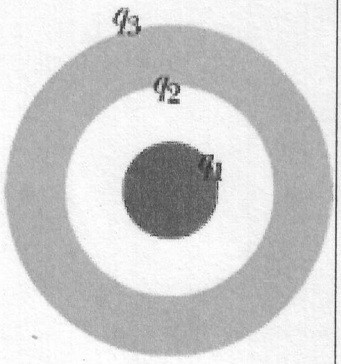
$= k_e \frac{4q}{2R} + k_e \frac{-q}{R} > 0$

6) A <u>conducting</u> spherical shell and a <u>conducting</u> solid sphere are concentric.

B

A charge -Q is placed on the outer shell and a charge -Q on the inner sphere.

A second later, how much charge will you find on the surface of the inner sphere [q_1]and the inside surface of the outer shell [q_2] the outside surface of the outer shell [q_3]?



(a) q_1 = -Q	q_2 = zero	q_3 = -Q
(b) q_1 = -Q	q_2 = +Q	q_3 = -2Q
(c) q_1 = zero	q_2 = zero	q_3 = -Q
(d) q_1 = -Q	q_2 = -Q	q_3 = zero
(e) q_1 = -Q	q_2 = +Q	q_3 = -Q

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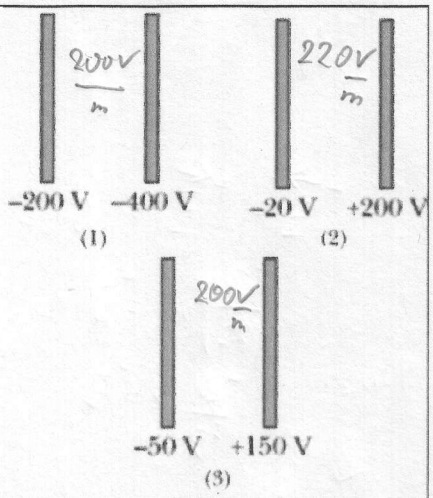
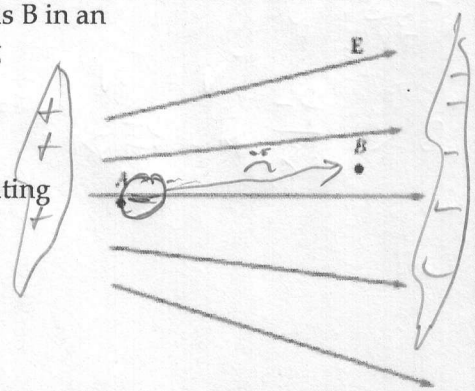
7) The figure shows three pairs of parallel plates with the same separation of 1 m, and the electric potential of each plate. The electric field between the plates is uniform and perpendicular to the plates.
Rank the pairs according to the magnitude of the electric field between the plates,



a) $|E_1| > |E_2| > |E_3|$
b) $|E_2| > |E_3| > |E_1|$
c) $|E_2| > |E_1| = |E_3|$
d) $|E_1| > |E_3| > |E_2|$
e) Something else

C 67

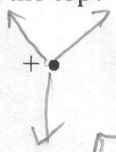
8) You move a negative charge from point A towards B in an electric field pointing right-ish, as shown. Talking about changes in electric potential energy or the related work input/output by you …



1. This requires you putting work into relocating the charge
2. This delivers work to you
3. Requires zero work
4. None of these

A 82

9) 4 charges are placed as shown. The charges are equal in magnitude, but differ in sign as shown.
Vertical and horizontal distances between adjacent charges are 1 m.
What direction is the force on the charge at the top?



$\vec{F}_{NET} = \vec{F}^{+} + \vec{F}^{+} + \vec{F}^{-}$

$F^{+} = k_e \frac{q^2}{(\sqrt{2})^2} = k_e \frac{q^2}{2}$

$\vec{F}^{+} + \vec{F}^{+} = \sqrt{2} \cdot k_e \frac{q}{2} \uparrow$

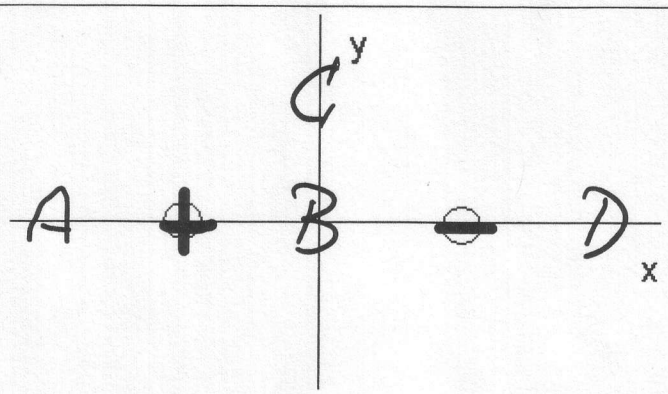
$\vec{F}^{-} = k_e \frac{q^2}{1} \downarrow$ wins

(a) ↑
(b) →
(c) ↓
(d) ←
(e) F = 0.

C 47

10)

D



A positive +1 C and a negative -1 C charge are located on the x-axis at x = -1 and x = 1 respectively.
Rank the value of the net **electric potential** at the following points A,B,C,D
A: (-2,0); B: (0,0); C: (0,1); D: (+2,0);
[not just magnitudes but also sign, like: +1 > -4]

A) C > A = B = D
B) A = B > C > D
C) A = D > B > C
D) A > B = C > D
E) A > B > C > D

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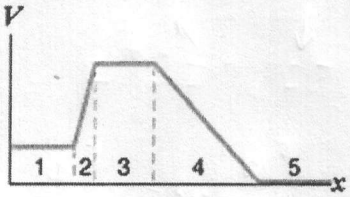
11) The figure below gives the electric potential *V* as a function of *x*.



D

An electron placed into this voltage landscape would feel the <u>strongest force to the left</u> in region

a) 1
b) 2
c) 3
d) 4
e) 5

(B)

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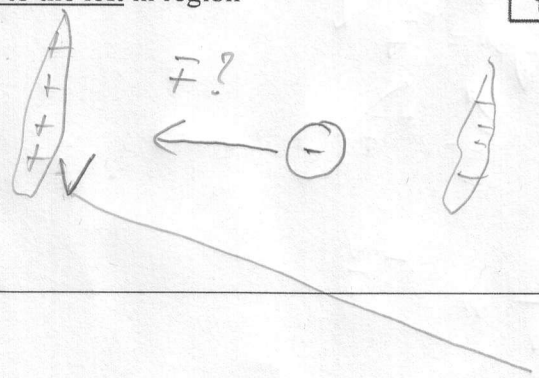
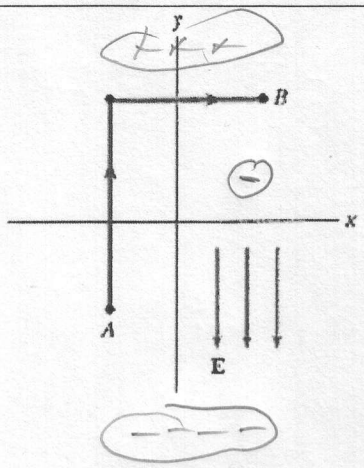


12) A uniform electric field of magnitude 30 V/m is directed in the negative *y* direction as shown. Point *A* is at (-2, -3) m, and point *B* is at (4, 5) m. Calculate the amount of work you have to either put into or receive out of moving a negative charge of -2 C from point A to point B.



A

a) 480 J work output
b) 480 J work input
c) 600 J work output
d) 600 J work input
e) None of these

$Work = \vec{F} \cdot \vec{d}$

$= q\vec{E}d$

$= (-2)(30)(8)\ J$

1

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13) An ball with mass = 2 kg and -1 C negative charge is moving parallel to the x axis with an initial speed of $+10^2$ m/s [in the +x direction] at the origin. Its speed is reduced to zero at the point x = 2 cm.
Calculate the potential difference between the origin and that point. Which direction does the electric field point?

B

1. ΔV = 10,000 V; E points left
2. ΔV = 10,000 V; E points right
3. ΔV = 200 V; E points left
4. ΔV = 200 V; E points right
5. something else

$\frac{1}{2} m v_i^2 \rightarrow q\Delta V$

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14) Two charged particles, originally with equal charge, are a distance *r* apart and exert a force of $F_{original}$ on each other, same magnitude of force on each charge.

B

Now we double both charges.
If we wanted to still have the same magnitude of electric force we would have to set the distance to

1. $r_{new} = 4\ r_{original}$
2. $r_{new} = 2\ r_{original}$
3. $r_{new} = r_{original}$
4. $r_{new} = ½\ r_{original}$
5. $r_{new} = ¼\ r_{original}$

$F = k_e \frac{q\,q}{r^2}$ $\times 2 \times 2$ $\times 2 \times 2$

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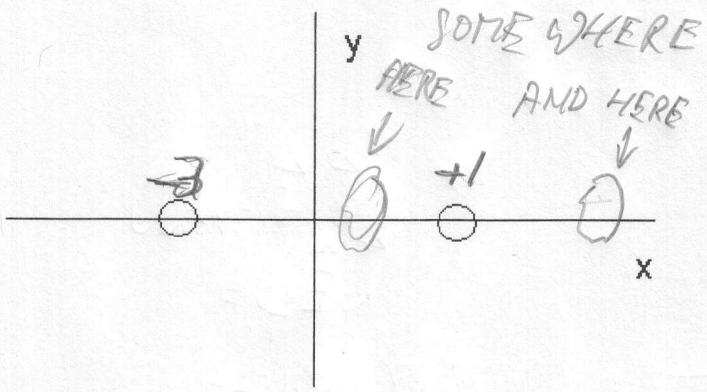
15)



D

2 charges are located on the x-axis.
A **-3C** charge at x = -1 and
A **+1C** charge at x = +1.
Looking for places <u>on the x-axis</u> where the net electric potential is zero, where could we find it?
We exclude "infinitely far away", instead looking for place a finite distance from the charges!
Considering these 3 regions:
Left = *to the left of the left charge [finite distance]*
Middle = *between the two charges*
Right = to the right of the right charge [finite distance]
In which of these regions could one find a place of zero electric potential?

A) *Only somewhere left*
B) *Only somewhere middle*
C) *Only somewhere right*
D) *Both, somewhere middle and somewhere right*
E) *Both somewhere left and somewhere right*

(c)

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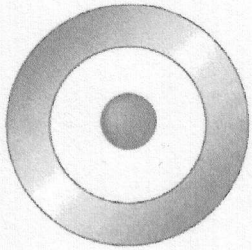
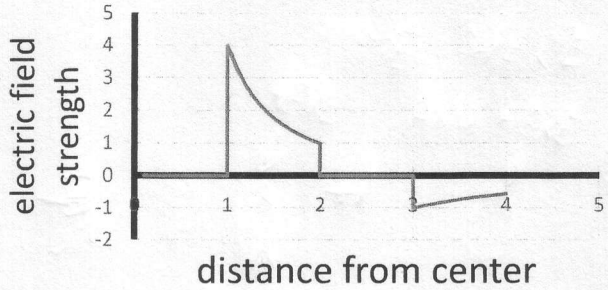
16)

D





For a metal sphere [radius = 1] surrounded by a concentric metal shell [inner radius = 2; outer radius = 3] the electric field varies as a function of radius as shown [positive E-filed pointing outwards, negative inwards].
The charges of the inner sphere Q_1 and the outer shell Q_2 must be:

a) Q_1: positive; Q_2: positive; $|Q_1| = |Q_2|$
b) Q_1: positive; Q_2: negative; $|Q_1| = |Q_2|$
c) Q_1: positive; Q_2: negative; $|Q_1| > |Q_2|$
d) Q_1: positive; Q_2: negative; $|Q_1| < |Q_2|$
e) Q_1: positive; Q_2: positive; $|Q_1| > |Q_2|$

Q_1 positive obviously
Q_2 negative probably
$|Q_1|$ vs $|Q_2|$???
how would the graph look if they were equal?

(C)

J3

17) A spherical conductor has a radius of 18 cm and charge of 200.0 μC. The electric field and the electric potential at a distance of 9 cm from the center are:

C

a) E = 55.6 MV/m V = 10 MV
b) E = 222 MV/m V = 20 MV
c) E = 0 MV/m V = 10 MV
d) E = 0 MV/m V = 20 MV
e) None of these

$E = 0 = \underline{ZERO}$

V : same everywhere in metal =>

$V_{SURFACE} = V_{9cm}$

$\Downarrow$

$V_{SURF} = k_e \frac{q}{18cm} = \underline{10\,MV}$

(D)

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Kinematics	$\mathbf{v} = \mathbf{v}_0 + \mathbf{a}\cdot t$ $\mathbf{x} = \mathbf{x}_0 + \mathbf{v}_0\cdot t + ½\cdot\mathbf{a}\cdot t^2$ $\mathbf{v}^2 = \mathbf{v}_0^2 + 2\mathbf{a}\cdot(\mathbf{x} - \mathbf{x}_0)$ $\bar{v} = (\mathbf{v} + \mathbf{v}_0) / 2$
Newton's Law	$\mathbf{F} = m\cdot\mathbf{a}$ $\mathbf{F}_{gravity} = m\cdot\mathbf{g}$ $\quad$ $\mathbf{g} = 9.80\ m/s^2$
Conservation of Energy	$KE_1 + U_1 + W_{in/out} = KE_2 + U_2$
Energy	Kinetik (linear): $\quad KE_{lin} = ½\, m\mathbf{v}^2$ Potential (gravity): $\quad U_g = m\,\mathbf{g}\,\mathbf{y}$
Work	$W = \mathbf{F}\cdot\mathbf{d} = F\,d\cos\theta$
Power (electrical)	$P = W/t = E/t$ $P = I\,\Delta V = I^2 R = (\Delta V)^2 / R$
Coulomb force	$\mathbf{F} = k_e\, q_1 q_2 / r^2$ $\quad$ along the connecting line
Electric field	$\mathbf{E} = \mathbf{F}/q = k_e \int_{volume} \frac{dq}{r^2}$ $\mathbf{E} = k_e\, q / r^2$ $\quad$ for a point charge / pointing radially $E = -gradient(V) = -\frac{dV}{dx}$
Electric flux	$\Phi_E = \int_{surface} \vec{E}\, d\vec{A}$
Gauss Law	$\Phi_E = \int_{closedsurface} \vec{E}\, d\vec{A} = q_{inside}/\varepsilon_o = 4\pi k_e \cdot q_{inside}$
Potential energy	$\underline{\Delta U} = U_B - U_A = -q\int_A^B \vec{E}\, d\vec{s} = \underline{q\,\Delta V}$
Potential	$\Delta V = \Delta U / q = -\int_A^B \vec{E}\, d\vec{s}$ $V = k_e q/r$ $\quad$ for a point charge
electron mass	$m_e = 9 \times 10^{-31}$ kg
proton mass	$m_p = 2 \times 10^{-27}$ kg
elementary charge	$e = 1.6 \times 10^{-19}$ C $\quad$ [electron: -e ; proton: +e]
Coulomb constant	$k_e = 9 \times 10^9\ Nm^2/C^2$
Permittivity of free space	$\varepsilon_o = 9 \times 10^{-12}\ C^2/Nm^2$ $\quad$ [$k_e = 1/4\pi\varepsilon_o$]