**A** **Part I Answer Sheet**

| | |
|---|---|
| (1) | (a) superconductor (b) metal (c) semiconductor or bca |
| (2) | $\frac{1}{4\pi\varepsilon_0}\frac{Q}{a}\left(\frac{1}{r}-\frac{1}{r+a}\right)$ |
| (3) | 0 |
| (4) | $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{a}\left(\frac{1}{r}-\frac{1}{r+a}\right)$, to the right |
| (5) | $\frac{1}{4\pi\varepsilon_0}\left(\frac{qQ}{(a+x)^2}-\frac{qQ}{(a-x)^2}\right)$ |
| (6) | $\frac{Qq}{\pi\varepsilon_0}\frac{1}{a^3}$ |
| (7) | $\frac{1}{2\pi}\sqrt{\frac{qQ}{\pi\varepsilon_0 ma^3}}$ or $\frac{1}{\pi}\sqrt{\frac{kqQ}{ma^3}}$ |
| (8) | $3.18 \times 10^5$ $A/m^2$ |
| (9) | $2.34 \times 10^{-5}$ m/s |
| (10) | $\frac{1}{4\pi\varepsilon_0}\frac{Q}{\sqrt{x^2+R^2}}$ |
| (11) | $\frac{1}{4\pi\varepsilon_0}\frac{Qx}{(x^2+R^2)^{3/2}}$ |
| (12) | outward |
| (13) | (5/6)R |
| (14) | $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ |
| (15) | 0 |
| (16) | $\frac{1}{4\pi\varepsilon_0}\frac{2Q}{r^2}$ |
| (17) | $\frac{-2Q}{4\pi b^2}$ |
| (18) | 4.2A |
| (19) | 2.8A |
| (20) | $7.2 \times 10^{-5}$ C |
| (21) | $\pi R^2 E_0$ |
| (22) | 0 |
| (23) | If the field inside the conductor is not zero, the field will exert a force on every free charge inside the conductor, giving the net charges a net motion. |
| (24) | We can construct a Gaussian surface inside the conductor. Since E field inside the conductor is zero, the charge enclosed in the Gaussian surface is zero. We can construct the Gaussian surface anywhere inside the conductor, so the charge inside is zero everywhere. |
| (25) | If the surface is not an equipotential surface, there will be a potential gradient along some path on the surface, causing the free charge to move. |

**B**

**Part I Answer Sheet**

| | |
|---|---|
| (1) | (5/6)R |
| (2) | outward |
| (3) | 4.2 A |
| (4) | 2.8 A |
| (5) | 7.2 x $10^{-5}$ C |
| (6) | If the field inside the conductor is not zero, the field will exert a force on every free charge inside the conductor, giving the net charges a net motion. |
| (7) | We can construct a Gaussian surface inside the conductor. Since E field inside the conductor is zero, the charge enclosed in the Gaussian surface is zero. We can construct the Gaussian surface anywhere inside the conductor, so the charge inside is zero everywhere. |
| (8) | If the surface is not an equipotential surface, there will be a potential gradient along some path on the surface, causing the free charge to move. |
| (9) | (a) superconductor (b) metal (c) semiconductor or bca |
| (10) | $\frac{1}{4\pi\varepsilon_0}\frac{Q}{a}\left(\frac{1}{r}-\frac{1}{r+a}\right)$ |
| (11) | 0 |
| (12) | $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{a}\left(\frac{1}{r}-\frac{1}{r+a}\right)$, to the right |
| (13) | $\pi R^2 E_0$ |
| (14) | 0 |
| (15) | $\frac{1}{4\pi\varepsilon_0}\left(\frac{qQ}{(a+x)^2}-\frac{qQ}{(a-x)^2}\right)$ |
| (16) | $\frac{Qq}{\pi\varepsilon_0}\frac{1}{a^3}$ |
| (17) | $\frac{1}{2\pi}\sqrt{\frac{qQ}{\pi\varepsilon_0 m a^3}}$ or $\frac{1}{\pi}\sqrt{\frac{kqQ}{ma^3}}$ |
| (18) | $\frac{1}{4\pi\varepsilon_0}\frac{Q}{\sqrt{x^2+R^2}}$ |
| (19) | $\frac{1}{4\pi\varepsilon_0}\frac{Qx}{(x^2+R^2)^{3/2}}$ |
| (20) | 3.18 x $10^5$ A/$m^2$ |
| (21) | 2.34 x $10^{-5}$ m/s |
| (22) | $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$ |
| (23) | 0 |
| (24) | $\frac{1}{4\pi\varepsilon_0}\frac{2Q}{r^2}$ |
| (25) | $\frac{-2Q}{4\pi b^2}$ |