The Open University

Science Supplementary Material
**S271 Discovering Physics**

# Computer Marked Assignment

Course and assignment number:
**S271 44**

Make sure you know how to use the CMA form: detailed instructions are given in your student handbook (or supplement).
You are strongly advised to attempt every question in this assignment.
If you do not wish to answer a question, pencil across the 'don't know' cell ('?').
If you think that a question is unsound in any way, pencil across the 'unsound' cell ('U') *in addition to* pencilling across either an answer cell or the 'don't know' cell.
*Note For each question, you* **must** *pencil across* **either** *the required number of answer cells* **or** *the 'don't know' cell.*

Covering: **Units 9–11**

Cut-off date:
**Friday 2 August 1996**

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## PART A

*The questions in this part of the assignment concern Unit 9.*

**Q1** [*Electric potential due to point charges*] A positive charge of $Q$ coulombs is placed at the origin O and a negative charge of $-Q$ coulombs is placed at a point on the $y$-axis 3 m from O, as shown in Figure 1. What is the electric potential at a point A on the $x$-axis, 4 m from O? Choose the option from the key that is closest to your answer. Pencil across *one* cell in row 1.

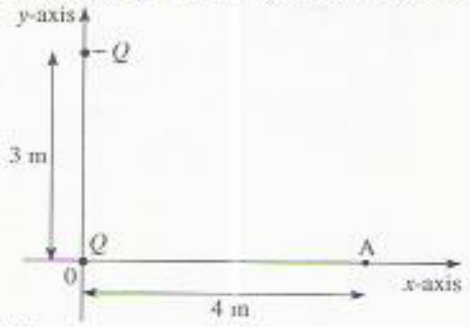


FIGURE 1

KEY for Q1

| | | | |
|---|---|---|---|
| A | $0.02Q/(4\pi\varepsilon_0)$ | E | $0.25Q/(4\pi\varepsilon_0)$ |
| B | $0.05Q/(4\pi\varepsilon_0)$ | F | $0.45Q/(4\pi\varepsilon_0)$ |
| C | $0.08Q/(4\pi\varepsilon_0)$ | G | $0.58Q/(4\pi\varepsilon_0)$ |
| D | $0.10Q/(4\pi\varepsilon_0)$ | H | $1.00Q/(4\pi\varepsilon_0)$ |

**Q2** [*Electric potential, field and force*] An experimenter repeating the Millikan oil drop experiment observes that an oil drop of mass $10^{-14}$ kg remains at rest between two horizontal charged plates separated by 1 cm. The upper plate is at a potential of 1040 V and the lower plate is at a potential of 0 V. Estimate the charge on the oil drop, including its sign, expressing your answer in terms of $e$, the charge of a proton. Pencil across *one* cell in row 2.

KEY for Q2

| | | | |
|---|---|---|---|
| A | $e$ | E | $-e$ |
| B | $2e$ | F | $-2e$ |
| C | $4e$ | G | $-4e$ |
| D | $6e$ | H | $-6e$ |

**Q3** [*Electric potential, field and force*] An electron moves in a region where the electric potential is given by the formula $V = Ax^2$, where the constant $A$ is 7.5 V m$^{-2}$. The potential $V$ does not depend on $y$ or $z$. What is the $x$-component of the electrostatic force experienced by the electron when it is at position $x = 3$ m? Pencil across *one* cell in row 3.

KEY for Q3

| | | | |
|---|---|---|---|
| A | $1.1 \times 10^{-17}$ N | E | $-1.1 \times 10^{-17}$ N |
| B | $7.2 \times 10^{-18}$ N | F | $-7.2 \times 10^{-18}$ N |
| C | $3.6 \times 10^{-18}$ N | G | $-3.6 \times 10^{-18}$ N |
| D | $1.2 \times 10^{-17}$ N | H | $-1.2 \times 10^{-17}$ N |

**Q4** [*Combining resistors in series and parallel*] When two resistors, $R_A$ and $R_B$, are combined in series and connected to a battery it is observed that the ratio $P_A/P_B$ of the power dissipated in $R_A$ to that dissipated in $R_B$ is equal to 10. If this arrangement is dismantled and the same two resistors connected in parallel to the same battery, what is the ratio $P_A/P_B$ in this new circuit? Pencil across *one* cell in row 4.

KEY for Q4

| | | | |
|---|---|---|---|
| A | 1 | E | 0.1 |
| B | 10 | F | 0.01 |
| C | 100 | G | 0.001 |
| D | 1000 | | |

**Q5** [*Energy stored and discharge of capacitors*] An electronic circuit designer wishes to produce a brief pulse of electrical energy by discharging a capacitor through a resistance. Just before the switch is closed to initiate the pulse, the potential difference across the capacitor plates is 100 V. Which of the combinations of capacitance and resistance listed in the key would be most suitable for producing a pulse of 0.5 J for $10^{-4}$ s? Pencil across *one* cell in row 5.

KEY for Q5

| | | | |
|---|---|---|---|
| A | $C = 10^{-8}$ F; $R = 10^4\ \Omega$ | E | $C = 10^{-4}$ F; $R = 1.0\ \Omega$ |
| B | $C = 10^{-8}$ F; $R = 10^2\ \Omega$ | F | $C = 10^{-4}$ F; $R = 0.01\ \Omega$ |
| C | $C = 10^{-6}$ F; $R = 100\ \Omega$ | G | $C = 10^{-2}$ F; $R = 1.0\ \Omega$ |
| D | $C = 10^{-6}$ F; $R = 0.01\ \Omega$ | H | $C = 10^{-2}$ F; $R = 0.01\ \Omega$ |