Q1.(a) State, in words, Coulomb's law.

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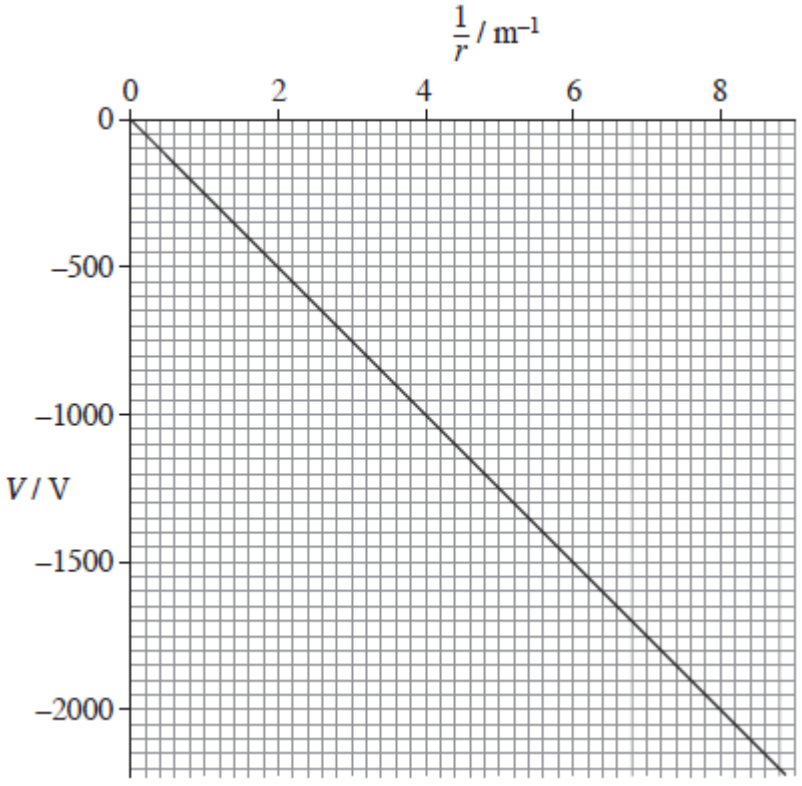
(2)

(b) The graph shows how the electric potential, V, varies with $\frac{1}{r}$, where r is the distance from a point charge Q.



State what can be deduced from the graph about how V depends on r and explain why all the values of V on the graph are negative.

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(2)

(c) (i) Use data from the graph to show that the magnitude of Q is about 30 nC.

(2)

(ii) A +60 nC charge is moved from a point where r = 0.20 m to a point where r = 0.50 m. Calculate the work done.

(2)

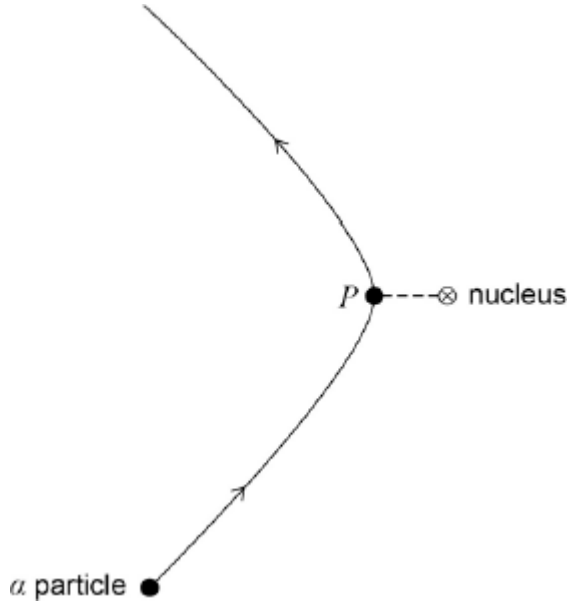
work done ..... J

(iii) Calculate the electric field strength at the point where r = 0.40 m.

electric field strength ..... V m^{-1}

(2)
(Total 10 marks)

Q2. The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path is the point of closest approach of the α particle to the nucleus.



Which of the following statements about the α particle on this path is correct?

A Its acceleration is zero at P.

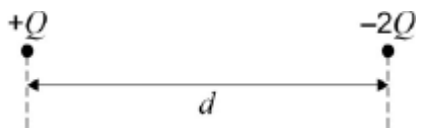
B Its kinetic energy is greatest at P.

C Its potential energy is least at P.

D Its speed is least at P.

(Total 1 mark)

Q3. The diagram shows two particles at distance d apart. One particle has charge $+Q$ and the other $-2Q$. The two particles exert an electrostatic force of attraction, F, on each other. Each particle is then given an additional charge $+Q$ and their separation is increased to distance $2d$.



Which of the following gives the force that now acts between the two particles?

A an attractive force of $\frac{F}{4}$ ⬭

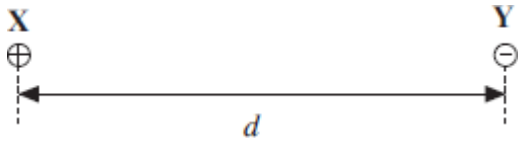
B a repulsive force of $\frac{F}{4}$ ⬭

C an attractive force of $\frac{F}{2}$ ⬭

D a repulsive force of $\frac{F}{2}$ ⬭

(Total 1 mark)

Q4. Two point charges, $\mathbf{X}$ and $\mathbf{Y}$, exert a force F on each other when they are at a distance d apart.



When the distance between them is 20 mm, the force they exert on each other is 0.5 F.

What is the distance d?

A 7 mm

B 14 mm

C 15 mm

D 28 mm

(Total 1 mark)

Q5. Two identical positive point charges, P and Q, separated by a distance *r*, repel each other with a force *F*. If *r* is decreased so that the electrical potential energy of Q is doubled, what is the force of repulsion?

A 0.5 *F*

B *F*

C 2*F*

D $4F$

(Total 1 mark)

Q6.(a) State, in words, Coulomb's law.

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(2)

(b) The diagram below shows two point charges of +4.0 nC and +6.0 nC which are 68 mm apart.

(i) Sketch on the diagram above the pattern of the electric field surrounding the charges.

(3)

(ii) Calculate the magnitude of the electrostatic force acting on the +4.0 nC charge.

magnitude of force ..... N

(2)

(c) (i) Calculate the magnitude of the resultant electric field strength at the mid-point of the line joining the two charges in the diagram above.
State an appropriate unit for your answer.

electric field strength ..... unit .....

(4)

(ii) State the direction of the resultant electric field at the mid-point of the line joining the charges.

.....

(1)

(Total 12 marks)

Q7. The force between two point charges is F when they are separated by a distance r. If the separation is increased to $3r$, what is the force between the charges?

A $\frac{F}{3r}$

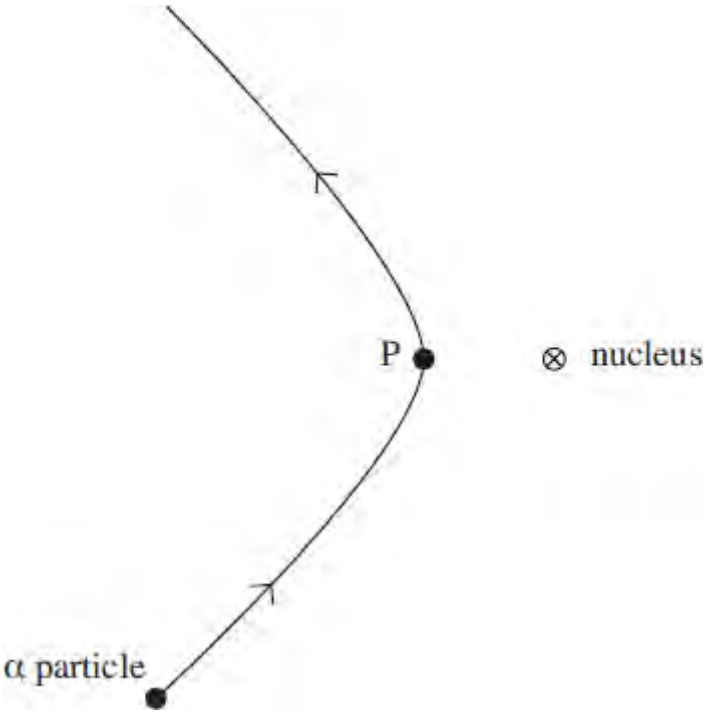
B $\frac{F}{9r}$

C $\frac{F}{3}$

D $\frac{F}{9}$

(Total 1 mark)

Q8. The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path is the point of closest approach of the α particle to the nucleus.



Which one of the following statements about the α particle on this path is correct?

A Its acceleration is zero at P.

B Its kinetic energy is greatest at P.

C Its speed is least at P.

D Its potential energy is least at P.

(Total 1 mark)

Q9. A repulsive force *F* acts between two positive point charges separated by a distance *r*.
What will be the force between them if each charge is doubled and the distance between them is halved?

A F

B $2F$

C $4F$

D $16F$

(Total 1 mark)

Q10. The repulsive force between two small negative charges separated by a distance r is F.

What is the force between the charges when the separation is reduced to $\frac{r}{3}$?

A $\frac{F}{9}$

B $\frac{F}{3}$

C $3F$

D $9F$

(Total 1 mark)

Q11. Two protons are 1.0×10^{-14} m apart. Approximately how many times is the electrostatic force between them greater than the gravitational force between them? (Use the Data and Formulae booklet)

A 10^{23}

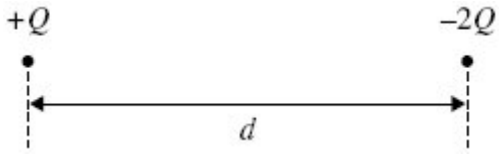
B 10^{30}

C 10^{36}

D 10^{42}

(Total 1 mark)

Q12.



The diagram shows two particles at a distance *d* apart. One particle has charge +*Q* and the other –2*Q*. The two particles exert an electrostatic force of attraction, *F*, on each other. Each particle is then given an additional charge +*Q* and their separation is increased to a distance 2*d*.
Which one of the following gives the force that now acts between the two particles?

A an attractive force of $\frac{F}{4}$

B a repulsive force of $\frac{F}{4}$

C an attractive force of $\frac{F}{2}$

D a repulsive force of $\frac{F}{2}$

(Total 1 mark)

Q13. (a) (i) Define the *electric field strength*, *E*, at a point in an electric field.

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(ii) State whether *E* is a scalar or a vector quantity.

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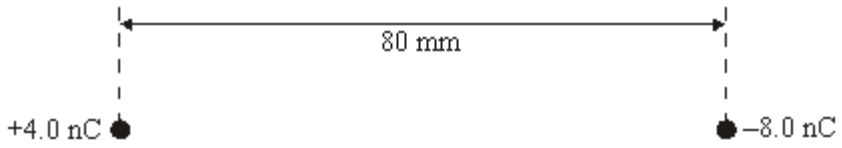
(3)

(b) Point charges of +4.0 nC and –8.0 nC are placed 80 mm apart, as shown in the figure below.



(i) Calculate the magnitude of the force exerted on the +4.0 nC charge by the –8.0 nC charge.

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(ii) Determine the distance from the +4.0 nC charge to the point, along the straight line between the charges, where the electric potential is zero.

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(4)

(c) Point **P** in the figure above is equidistant from the two charges.

(i) Draw two arrows on the figure above at **P** to represent the directions and relative magnitudes of the components of the electric field at **P** due to each of the charges.

(ii) Hence draw an arrow, labelled **R**, on the figure above at **P** to represent the direction of the resultant electric field at **P**.

(3)
(Total 10 marks)

Q14. Two protons, each of mass *m* and charge *e*, are a distance *d* apart. Which one of the following expressions correctly gives the ratio $\left(\frac{\text{electrostatic force}}{\text{gravitational force}}\right)$ for the forces acting between them?

A $\frac{4\pi\varepsilon_0 e^2}{Gm^2}$

B $\frac{Ge^2}{4\pi\varepsilon_0 m^2}$

C $\frac{e^2 m^2}{4\pi\varepsilon_0 G}$

D $\frac{e^2}{4\pi\varepsilon_0 Gm^2}$

(Total 1 mark)

Q15. Two isolated point charges are separated by 0.04 m and attract each other with a force of 20 μN. If the distance between them is increased by 0.04 m, what is the new force of attraction?

A 40 μN

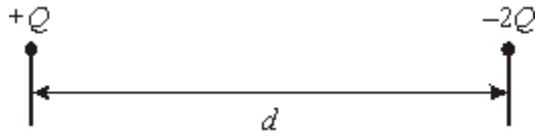
B 20 μN

C 10 μN

D 5 μN

(Total 1 mark)

Q16.



The diagram shows two particles at a distance *d* apart. One particle has charge +*Q* and the other –2*Q*. The two particles exert an electrostatic force of attraction, *F*, on each other. Each particle is then given an additional charge +*Q* and their separation is increased to a distance of 2*d*. Which one of the following gives the force that now acts between the two particles?

A an attractive force of $\frac{F}{4}$

B a repulsive force of $\frac{F}{4}$

C an attractive force of $\frac{F}{2}$

D a repulsive force of $\frac{F}{2}$

(Total 1 mark)

Q17. The force between two point charges is *F* when they are separated by a distance *r*. If the separation is increased to 3*r* what is the force between the charges?

A $\frac{F}{3r}$

B $\frac{F}{9r}$

C $\frac{F}{3}$

D $\frac{F}{9}$

(Total 1 mark)