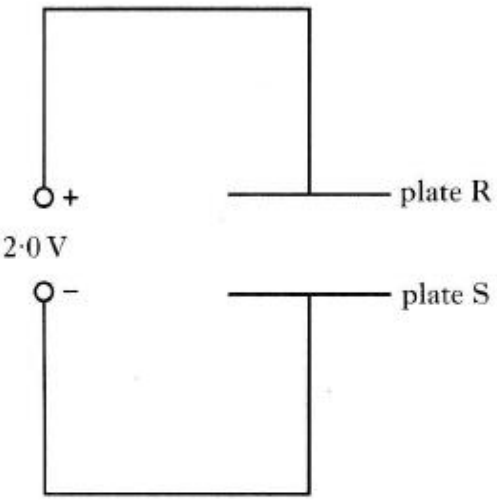
# Exercise 11- Standard Model and Forces on Charged Particles

Past Paper Homework Questions

1. Two parallel metal plates, R and S, are connected to a 2·0 V d.c. supply as shown.




An electron is moved from plate R to plate S.

The gain in electrical potential energy of the electron is

A $8{\cdot}0 \times 10^{-20}$ J

B $1{\cdot}6 \times 10^{-19}$ J

C $3{\cdot}2 \times 10^{-19}$ J

D $6{\cdot}4 \times 10^{-19}$ J

E $1{\cdot}3 \times 10^{-19}$ J.

2. An electron is accelerated from rest through a potential difference of 2·0 kV.

The kinetic energy gained by the electron is

A $8{\cdot}0 \times 10^{-23}$ J

B $8{\cdot}0 \times 10^{-20}$ J

C $3{\cdot}2 \times 10^{-19}$ J

D $1{\cdot}6 \times 10^{-16}$ J

E $3{\cdot}2 \times 10^{-16}$ J.

3. A student writes the following statements about electric fields.

I There is a force on a charge in an electric field.

II When an electric field is applied to a conductor, the free electric charges in the conductor move.

III Work is done when a charge is moved in an electric field.

Which of the above statements is/are correct?

A I only

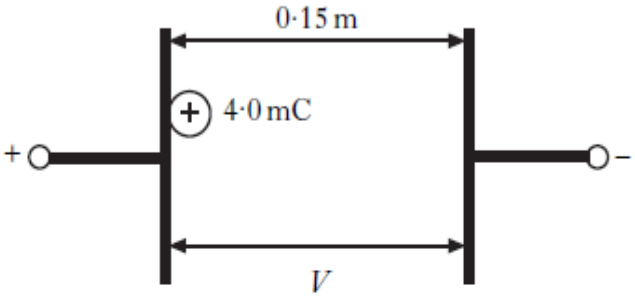
B II only

C I and II only

D I and III only

E I, II and III

4. A potential difference, $V$, is applied between two metal plates. The plates are 0·15 m apart. A charge of +4·0 mC is released from rest at the positively charged plate as shown.




The kinetic energy of the charge just before it hits the negative plate is 8·0 J.

The potential difference between the plates is

A $3{\cdot}2 \times 10^{-2}$ V

B 1·2 V

C 2·0 V

D $2{\cdot}0 \times 10^{3}$ V

E $4{\cdot}0 \times 10^{3}$ V.

5. The potential difference between two points is

A the work done in moving one electron between the two points

B the voltage between the two points when there is a current of one ampere

C the work done in moving one coulomb of charge between the two points

D the kinetic energy gained by an electron as it moves between the two points

E the work done in moving any charge between the two points.

6. A student writes the following statements about electric fields.

I There is a force on a charge in an electric field.

II When an electric field is applied to a conductor, the free electric charges in the conductor move.

III Work is done when a charge is moved in an electric field.

Which of the statements is/are correct?

A I only

B II only

C I and II only

D I and III only

E I, II and III

7. One volt is equivalent to one

A farad per coulomb

B ampere per ohm

C joule per ampere

D joule per ohm

E joule per coulomb.

8. The letters **X**, **Y** and **Z** represent the missing words from the following passage.

*There are four fundamental forces.*

*Gravity and the electromagnetic force act over a …***X**… *range.*

*The strong and weak force act over a …***Y**… range.

*The …***Z**… *force is responsible for beta decay.*

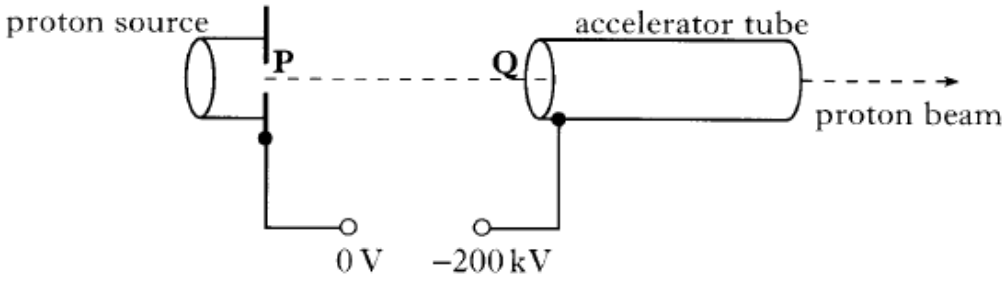
Which row in the table identifies the missing words represented by the letters **X**, **Y** and **Z**?

| | **X** | **Y** | **Z** |
|---|---|---|---|
| A | short | long | strong |
| B | long | short | strong |
| C | long | short | weak |
| D | long | long | electromagnetic |
| E | short | long | weak |

9. Which row in the table shows an example of a hadron, lepton and boson?

| | *Hadron* | *Lepton* | *Boson* |
|---|---|---|---|
| A | neutron | photon | electron |
| B | electron | neutron | photon |
| C | photon | electron | neutron |
| D | neutron | electron | photon |
| E | electron | photon | neutron |

10. The diagram below shows the basic features of a proton accelerator. It is enclosed in an evacuated container.




Protons released from the proton source start from rest at **P**.
A potential difference of 200 kV is maintained between **P** and **Q**.

(*a*) What is meant by the term *potential difference of 200 kV*? **1**

(*b*) Explain why protons released at **P** are accelerated towards **Q**. **1**

(*c*) Calculate:

(i) the work done on a proton as it accelerates from **P** to **Q**; **2**

(ii) the speed of a proton as it reaches **Q**. **2**

(*d*) The distance between **P** and **Q** is now halved.

What effect, if any, does this change have on the speed of a proton as it reaches **Q**? Justify your answer. **2**

**(8)**

11. (*a*) A conversation is overheard between two young pupils who are discussing their science lessons.

Pupil A *"We learned in science today that the nucleus of an atom is made of protons which are positively charged and neutrons which have no charge."*

Pupil B *"That's interesting because we learned in science that like charges repel. How come the protons in the nucleus don't fly apart?"*

Pupil A *"I don't know."*

Write a paragraph that would explain to the pupils why the protons in a nucleus do not fly apart. **3**

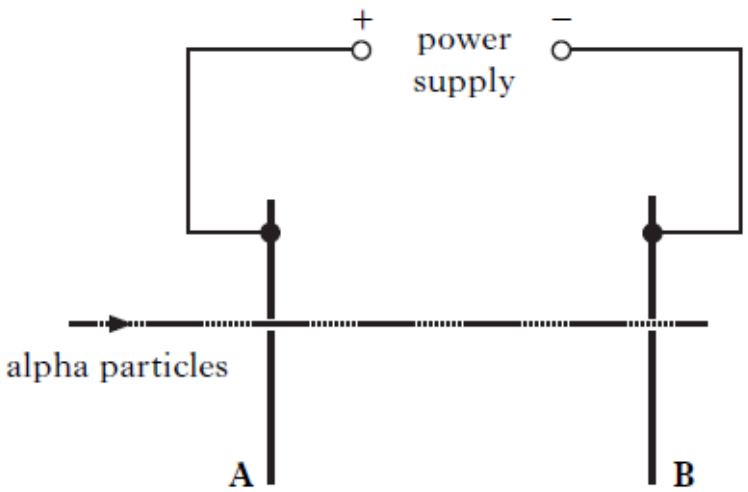
(*b*) Protons and neutrons each contain two different types of quark: the up quark which has an electric charge of $+\frac{2}{3}$ and the down quark which has an electric charge of $-\frac{1}{3}$.

Use this information to show:

(i) the overall charge on the proton is +1;

(ii) the overall charge on the neutron is zero. **2**

12. The apparatus shown in the diagram is designed to accelerate alpha particles.




An alpha particle travelling at a speed of $2{\cdot}60 \times 10^{6}\,\text{m s}^{-1}$ passes through a hole in plate A. The mass of an alpha particle is $6{\cdot}64 \times 10^{-27}\,\text{kg}$ and its charge is $3{\cdot}2 \times 10^{-19}\,\text{C}$.

(*a*) When the alpha particle reaches plate B, its kinetic energy has increased to $3{\cdot}05 \times 10^{-14}\,\text{J}$.

Show that the work done on the alpha particle as it moves from plate A to plate B is $8{\cdot}1 \times 10^{-15}\,\text{J}$. **2**

(*b*) Calculate the potential difference between plates A and B. **2**

(*c*) The apparatus is now adapted to accelerate **electrons** from A to B through the same potential difference.

How does the increase in the kinetic energy of an electron compare with the increase in kinetic energy of the alpha particle in part (*a*)?

Justify your answer. **2**

**(6)**

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