

Student: _____

Max. Marks : 18 Marks

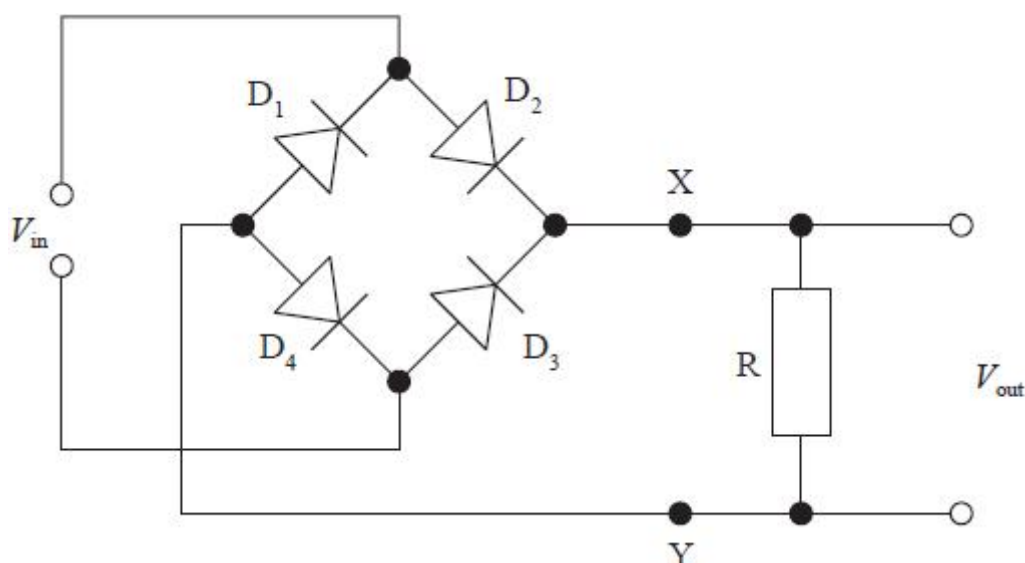
Time : 18 Minutes

Q1.

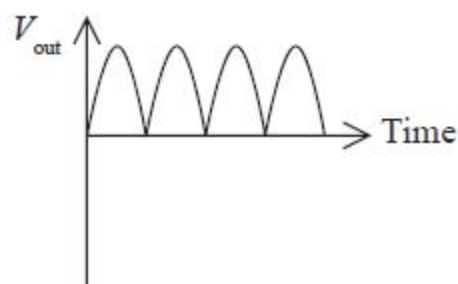
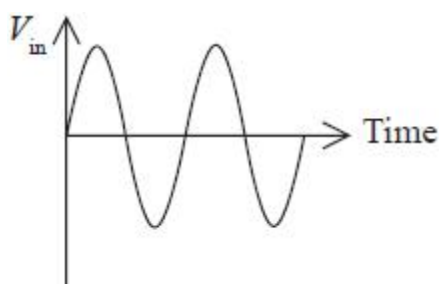
Power supplies provide either alternating or direct currents and potential differences.

It is possible to convert alternating currents and p.d.s, to direct currents and p.d.s using diodes.

The power supply provides an input V_{in} to the circuit shown. The circuit includes four diodes D_1 , D_2 , D_3 and D_4 and a resistor R . The circuit produces an output potential difference V_{out} .



A graph of V_{in} against time and a corresponding graph of V_{out} against time are shown below.



(i) Explain the operation of this circuit. Your answer should refer to D_1 , D_2 , D_3 and D_4 .

(3)

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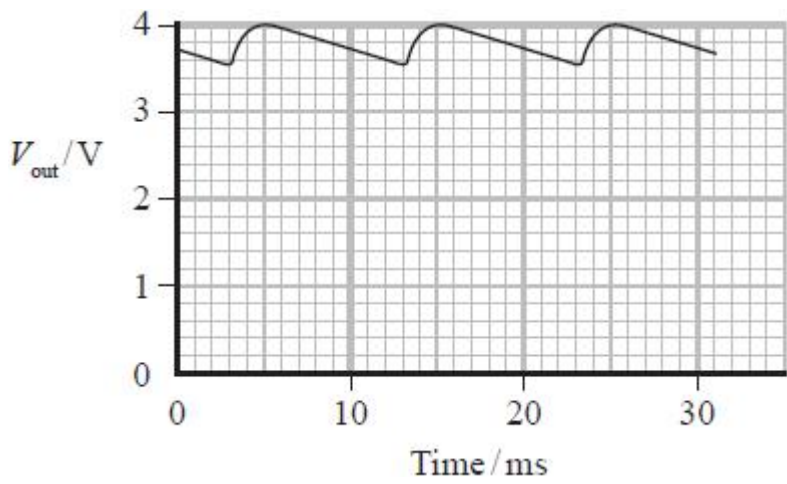
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(ii) A capacitor is added between points X and Y in the circuit.

The new graph of V_{out} against time is shown below.



Determine a value for the capacitance of the capacitor.
resistance of $R = 2.2\text{ k}\Omega$

(3)

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Capacitance =

(Total for question = 6 marks)

Q2.

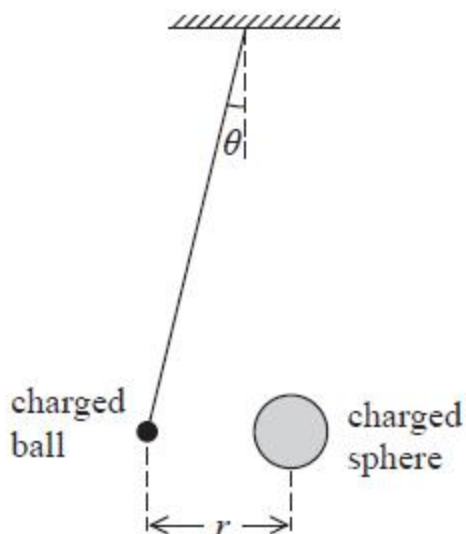
Two protons, separated by a distance x , experience a repulsive force F .
If the separation is reduced to $x/3$ the force between the protons will be

- ☐ A $F/9$
- ☐ B $F/3$
- ☐ C $3F$
- ☐ D $9F$

(Total for Question = 1 mark)

Q3.

A student carries out an experiment to investigate the force acting between two charged objects. A lightweight negatively-charged ball is freely suspended from the ceiling by an insulating thread. The ball is repelled by a negatively-charged sphere that is placed near it on an insulated support. The angle of deflection is θ and r is the distance between the centres of the ball and the sphere.



- (a) (i) Draw a free-body force diagram for the suspended ball.

(2)



- (ii) The weight of the suspended ball is W .

Show that the force of repulsion F on the suspended ball is given by

$$F = W \tan \theta$$

(2)

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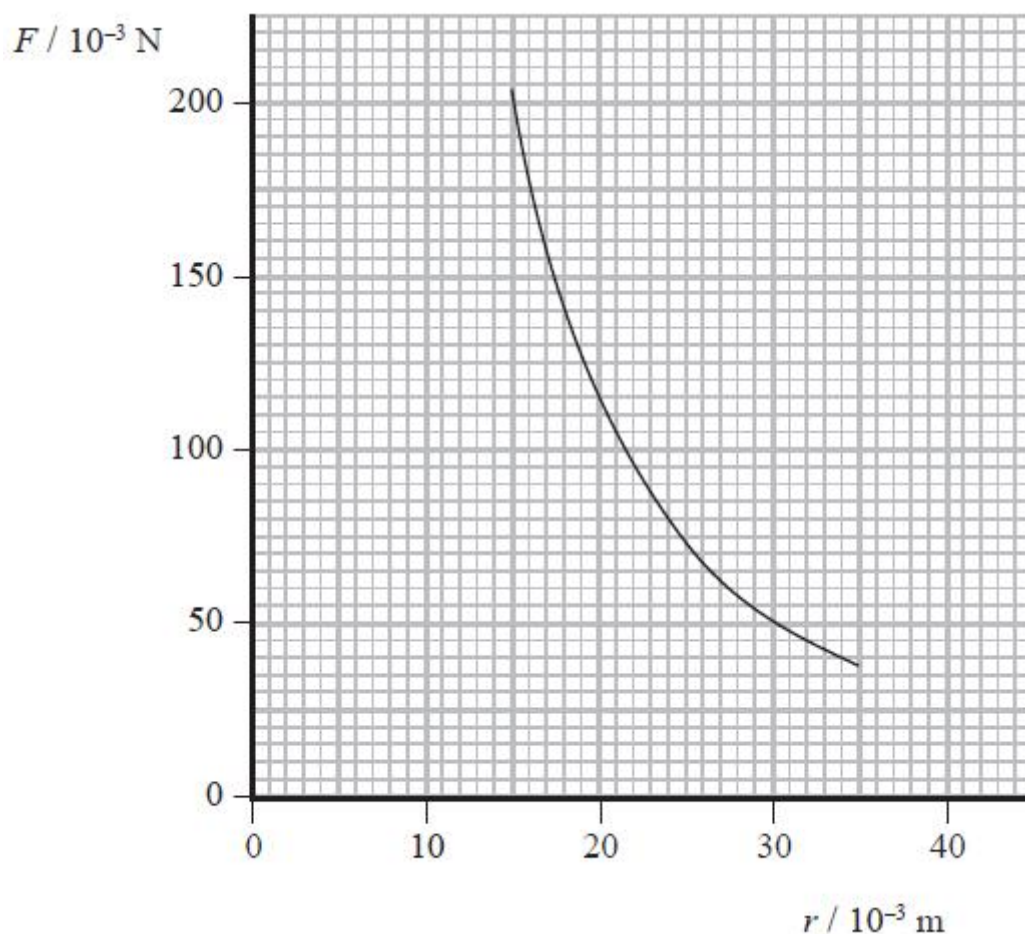
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(b) (i) The student can increase the magnitude of the force by moving the sphere towards the suspended ball. She takes pairs of measurements of r and θ and calculates the magnitude of the force F . She then plots a graph of F against r .



Use readings from the graph to demonstrate that the relationship between F and r obeys an inverse square law.

(4)

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(ii) The charge on the sphere is 100 times greater than the charge on the ball. Calculate the charge on the ball.

(3)

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Charge =

(Total for question = 11 marks)