Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic : 7_ Electric Field 2

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Student:_____

Max. **Marks : 20 Marks**

Time : 20 Minutes

Q1.

Our understanding of the atom has developed over time, from early models in which atoms were considered to be hard incompressible spheres, through to the nuclear model of the atom and the ladder model in which electrons exist in a discrete number of allowed energy states.

The nuclear model of the atom was established following a series of experiments in which alpha particles were directed at thin gold foil.

(i) An alpha particle approaching a gold nucleus, $^{197}_{79}\text{Au}$, head-on will be brought to rest and returned along its original path.

Calculate the minimum distance between the alpha particle and the nucleus for alpha particles of energy of 5.5 MeV.

(4)

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Minimum distance = ...

(ii) It is observed that electrons, with energy of 5.5 keV, are diffracted as they pass through the thin gold foil.

Explain a conclusion about the electrons that can be made from this observation.
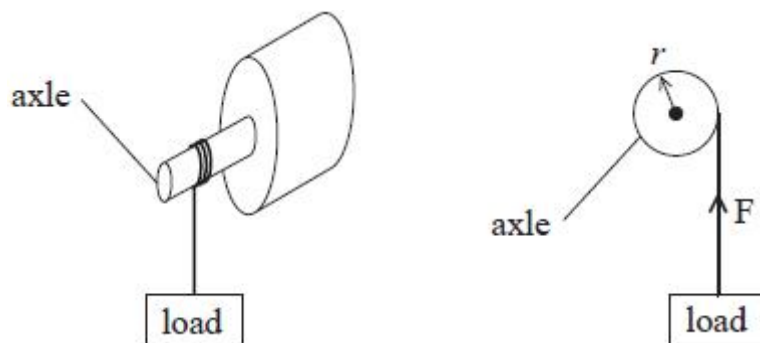
(3)

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(Total for question = 7 marks)

Q2.

Motors usually have a rotating component which can do work *W*.

(a) A motor lifts a load in a time *t*. The axle of the motor has a radius *r* and exerts a force *F*.

axle

load

r

axle

F

load

The power produced by a motor can be calculated by using the following word equation.

Power = moment of the force exerted by the rotating axle × angular velocity

Derive this equation, starting with power $P = \dfrac{W}{t}$.

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(b) An electrostatic motor was first demonstrated by Benjamin Franklin in 1750.

The diagram shows a simplified version of part of this motor.
This consists of a rod, with an oppositely charged sphere at either end, which rotates around a fixed pivot.
Two stationary charged spheres apply a force on the spheres at either end of the rod.

stationary charged sphere   (−)

rod   pivot

(+)━━━━━●━━━━━(−)

(+) stationary charged sphere
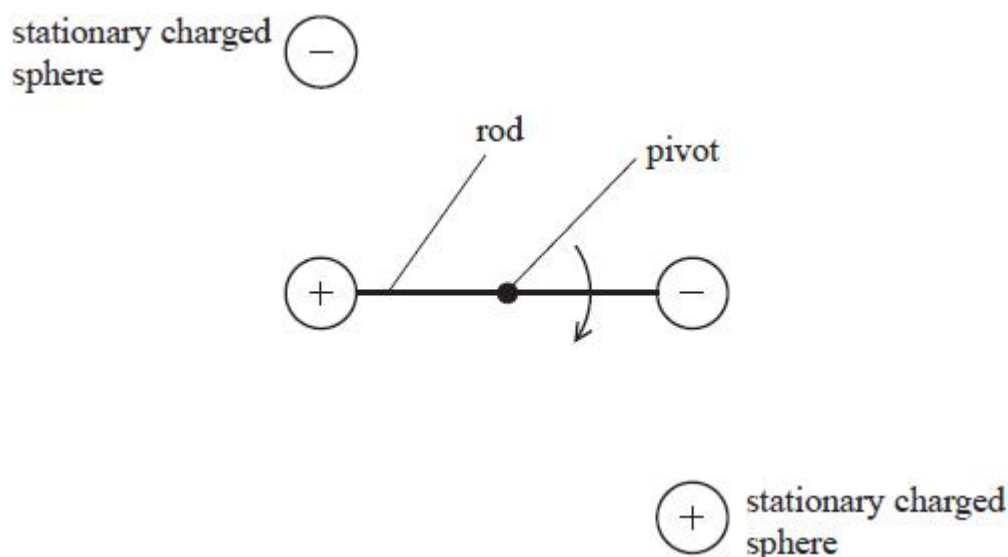
(i) In the diagram below, electric field lines have been drawn around one pair of these spheres.
    Add to the diagram to show

- the directions of the field lines
- the lines of equipotential.
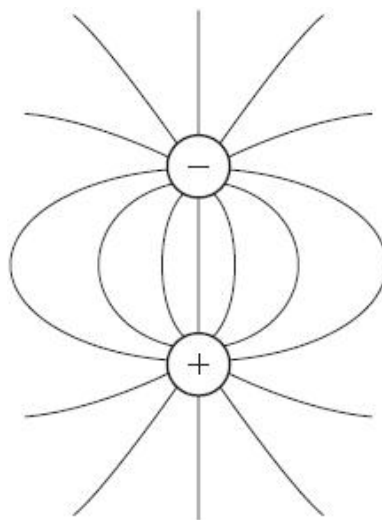
(ii) The distance between the centres of each charged sphere in this pair is 5.0 cm.
Show that the force between this pair of charged spheres is about 0.04 N.
charge on each sphere = 0.10 µC

(2)

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(c) The table shows the typical power and the corresponding angular velocity required for three different appliances.

	Power / W	Angular velocity / rad s⁻¹
Electric car	2.0×10^4	300
Vacuum cleaner	1.4×10^3	1000
Small pond pump	0.5	200

Deduce which of these appliances, in principle, could use the electrostatic motor in (b).
You should use the word equation in (a) and assume that the length of the rod in the electrostatic motor is 8.0 cm.
Assume that the electrostatic motor would deliver a constant force throughout one complete rotation.

(4)

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(Total for question = 13 marks)