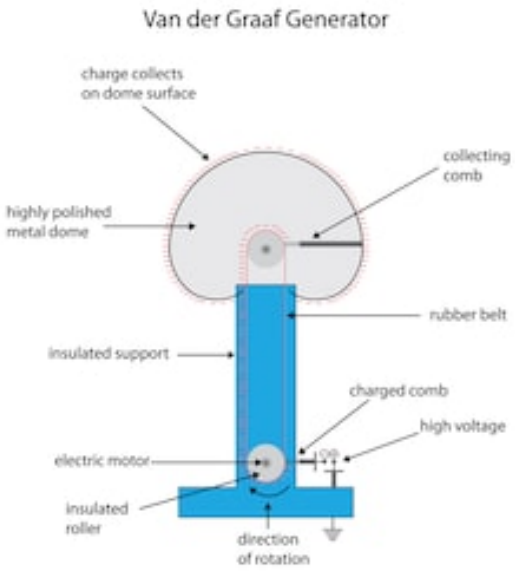
PHYSICS ATAR 12 **TEST 2 – ELECTROMAGNETISM** **2018**

TOTAL MARKS = 50

Question 1

A Van de Graaff generator creates an electric charge on the surface of its aluminium dome due to the friction of a rubber belt rotating inside the dome. When small pieces of cotton-wool are gently tossed towards a charged Van de Graaff generator, the cotton-wool pieces are attracted to the dome. After being in contact with the dome for a short time the cotton-wool pieces are repelled from the dome. Explain these observations using the appropriate physics concepts.

(3 marks)



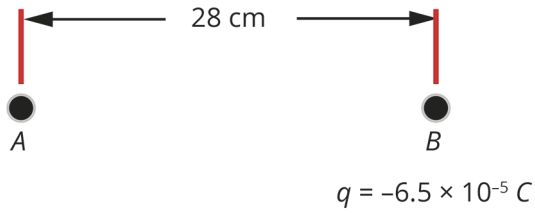
Question 2

On the diagram below, draw t least 5 field lines showing the resulting field lines from two positively charged particles, of equal charge.

(3 marks)

Question 3

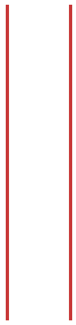
Calculate the strength and direction of the electric field at point A 28 cm from point B which has a charge q = −6.5 × 10−5 C as indicated in the diagram below. **(5 marks)**



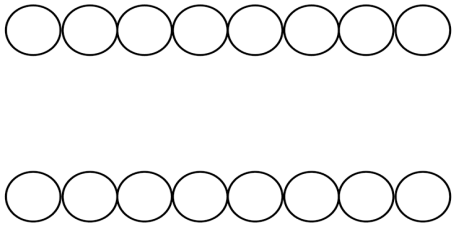
Question 4

a) Two wire conductors run parallel to each as shown below. Draw the direction of conventional current through the wires to create a force of attraction between them.

(1 mark)



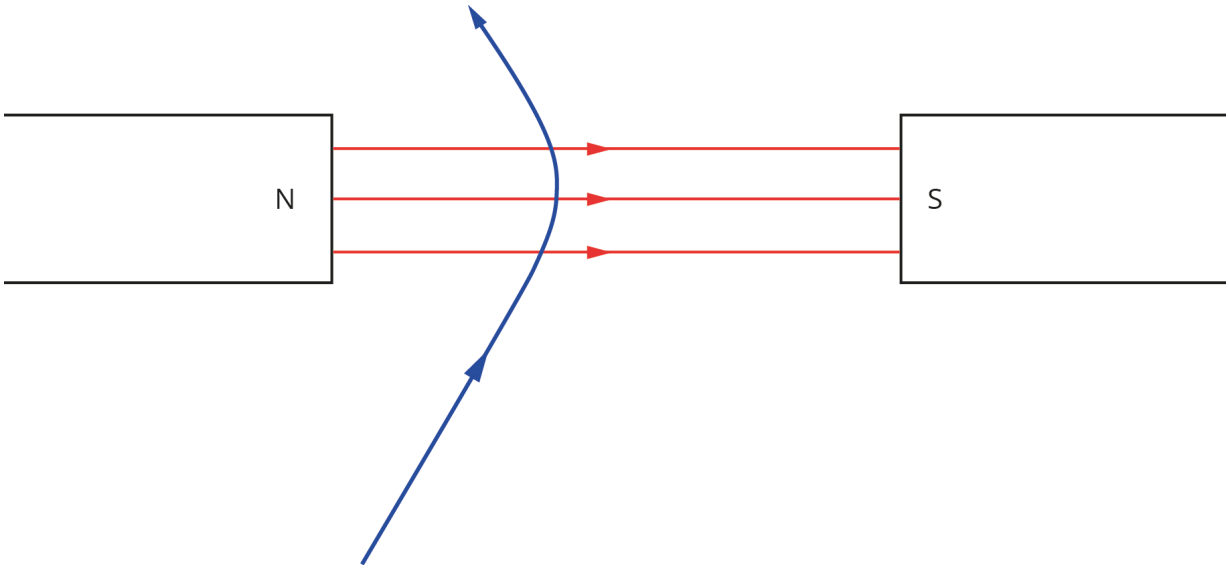
b) Draw lines around the solenoid below to represent both the direction and strength of the magnetic field that is created around it when a current flows through it. **(3 marks)**



c) To determine the charge on radiation emitted from the decay of a new radioactive nucleotide, the radiation is directed through a magnetic field as represented in the diagram below. When the radiation passes through the field it is deflected upwards. What is the charge on the radiation?

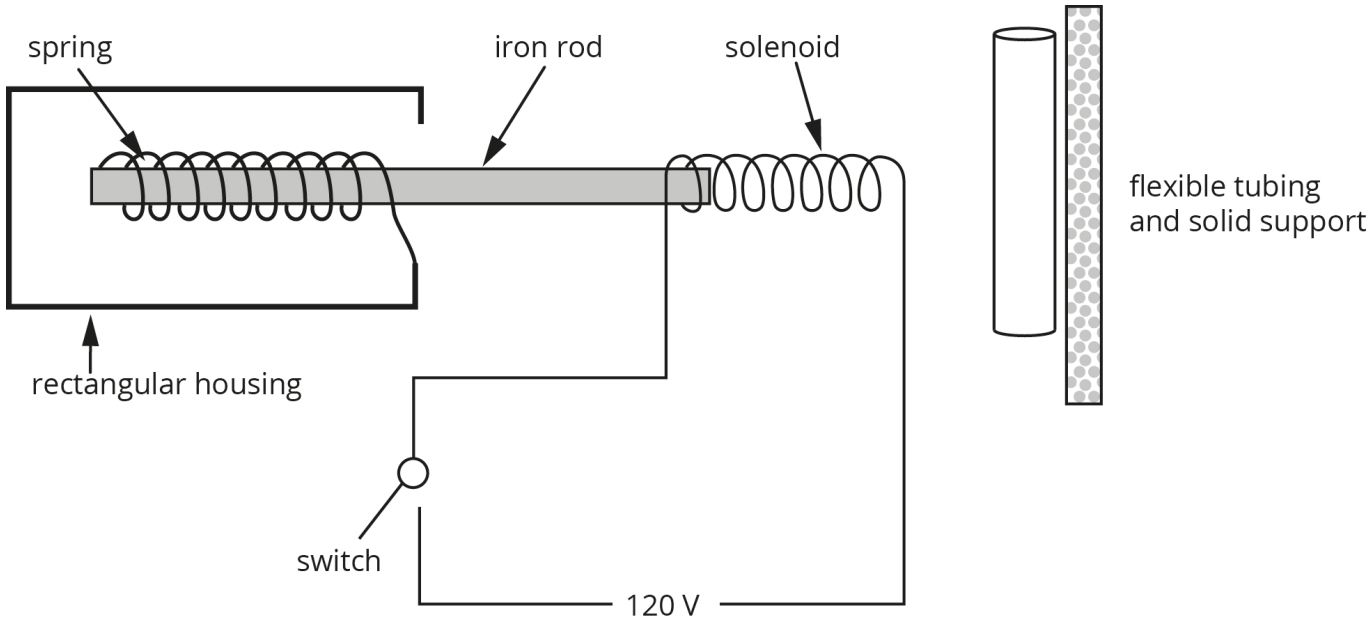
(1 mark)

_____



Question 5

A student designs a simple solenoid valve system to control flow of a liquid through flexible tubing by closing and opening the tubing. It is comprised of an iron rod with a spring coiled around it at one end. One end of the spring is attached at one end of the rod and its other end is attached to a rectangular housing. The tubing is fixed to a solid support. The system is represented by the diagram below.



a) Using the appropriate physics concepts, explain how the system will operate to close and open the tubing. **(3 marks)**

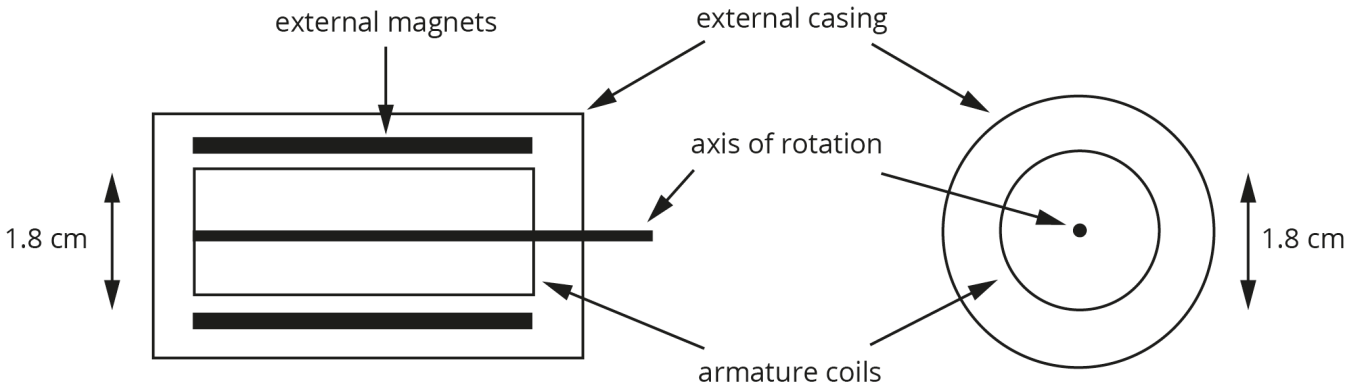
b) Give two ways to increase the force with which the iron rod will push the tubing closed. **(2 marks)**

Question 6

A student examining a small electric motor notes that the specifications under optimal operating conditions are as follows:

torque = 2.4×10^{-2} N m
voltage = 9.0 V
current = 1200 mA
windings = 5000 turns

To estimate the strength of the magnetic field the motor would operate with under optimal conditions, the student measures the cylindrical motor and estimates the length of the armature coil of the motor to be 3.0 cm with a diameter of 1.8 cm.



a) When operating under optimal conditions, what force would the moment arm of the motor experience? **(3 marks)**

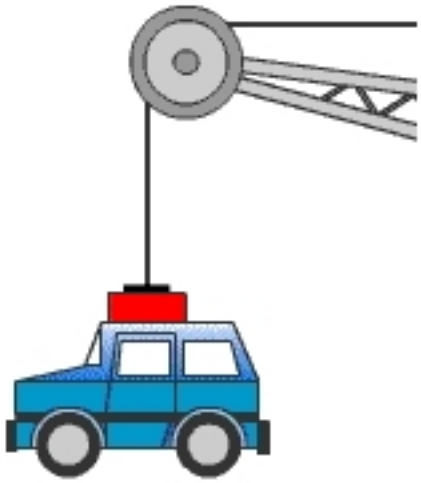
b) **Estimate** the magnetic field strength for the motor by carrying out the appropriate calculation. **(3 marks)**

Question 7

An electromagnet at a scrap yard is used to lift a 950 kg car. The electromagnet has 200 m of wire coiled around its iron core and generates a magnetic field of 1.2 T at its surface.

a) What current needs to pass through the coils of wire to give the required strength field?

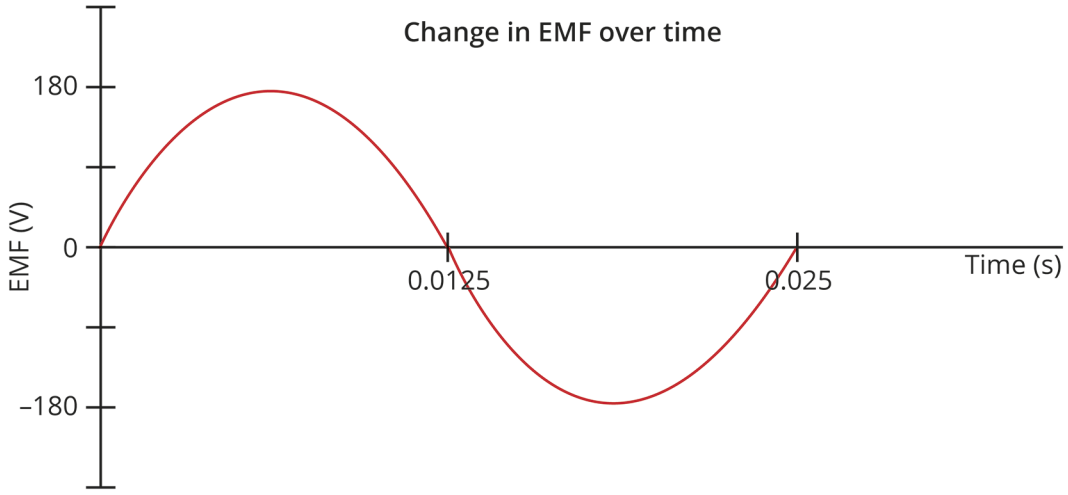
(4 marks)



b) What mass could the electromagnet lift at a distance of 1.00 m from the electromagnet if it had a current of 50 A flowing through it? **(5 marks)**

Question 8

An engineer was testing a new generator for a wind turbine. The turbine was placed in a wind tunnel and connected to the generator, and the voltage produced over time was measured.
The generator consisted of a coil of 5000 turns and radius 50 cm. The graph below shows the results of these measurements.



a) What is the frequency with which the generator rotates? **(1 mark)**

b) What is the strength of the magnetic field used in this generator? **(5 marks)**

c) What is the root mean square a EMF produced by the turbine? **(2 marks)**

Question 9

The Kwinana Power Station in Naval Base, Western Australia, has a generating capacity of 420 MW. The power station is located long distances from the homes to which it supplies power, and it is not practical to send the current along wires at 240 V (the voltage directly used in the home) as this would lead to large power losses in the wires carrying the current. Instead the power station has 66 000 V, 132 000 V and 330 000 V transmission lines to the South West Interconnected System.

a) Explain why there would be large losses if the power were to be supplied at 240 V. Include in your answer any mathematical relationships that are relevant. **(2 marks)**

b) 50MW of power is transmitted to Margaret River at 132 000 V. Calculate the power loss, and therefore work out the voltage delivered, if the powerlines to Margaret River produce a resistance of 7.5 ohms. **(2 marks)**

c) If the voltage is now stepped down to 450 V using a transformer with 5000 primary turns, how many turns must the secondary coil have? [To nearest whole number] **(2 marks)**

END OF TEST