TORQUE, ELECTRIC & MAGNETIC FIELDS TEST 2016

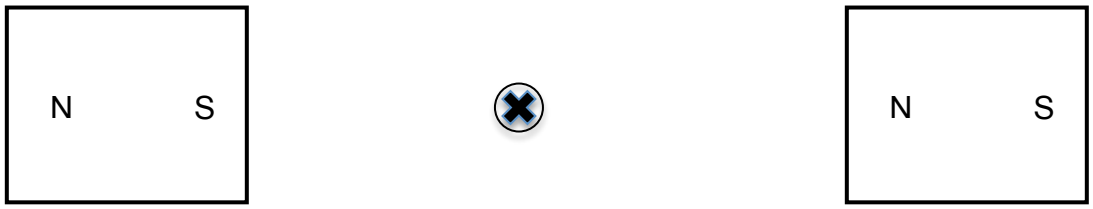
Time: 55 minutes Total Marks: [50]

Name:_____

1

(a) Sketch the resultant magnetic field in the region between the two bar magnets shown below and the wire carrying current into the page.
Indicate the direction of the force acting on the wire

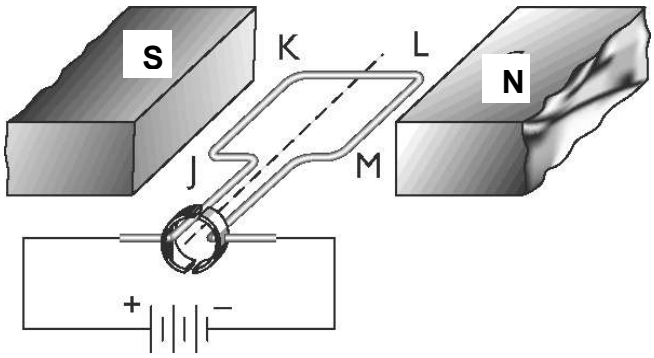
[4 marks]



(b) Sketch the electric field between the positively and negatively charged conducting spheres shown below. Each sphere has the same magnitude of charge.

[3 marks]

2. A simplified diagram of a DC motor is shown at right. The rectangular coil of the motor has 500 turns of wire, the length JK is 6.0 cm, the width KL is 4.5 cm and the magnetic field between the magnets is measured to be 0.015 T. The current flowing through the coil, before the motor picks up speed, is 8.0 A.



(a) On the diagram sketch arrows to show the forces acting on each side of the coil as current flows through the motor, and state the direction that the coil will rotate.

[2 marks]

(b) Calculate the magnitude of the force acting on side JK (before the motor picks up speed).

[2 marks]

(c) Calculate the torque on the motor when the coil is in the position shown.

[3 marks]

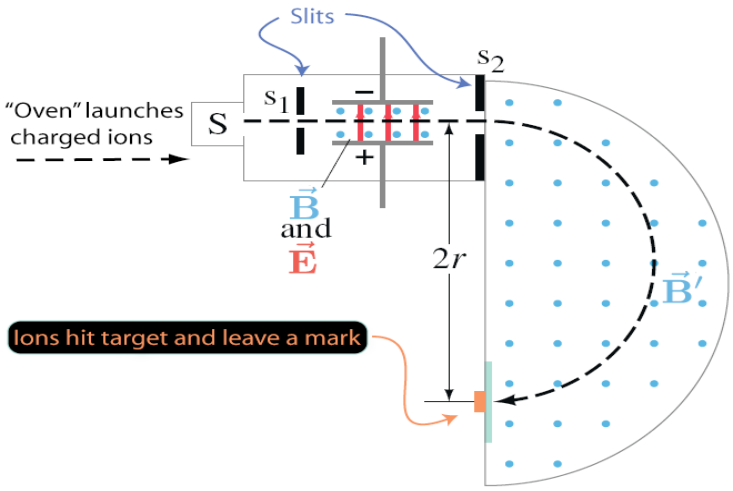
(d) How can the motor be modified to produce a more uniform torque?

[2 marks]

(e) What is the purpose of the split ring commutator?

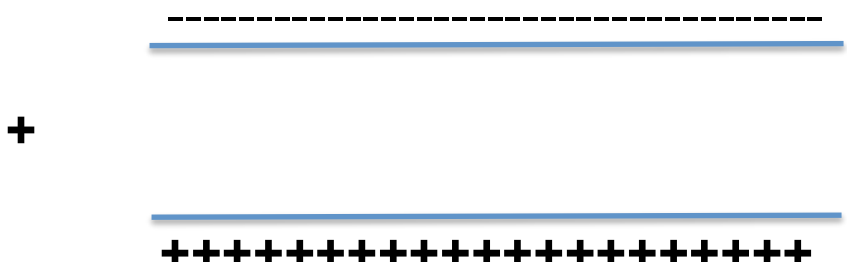
[2 marks]

3. A cross-section view of a mass spectrometer is shown at right. Positive ions are accelerated towards slit S_1 before the velocity selector ensures that only ions moving at a certain speed are allowed to pass through slit S_2 and enter the deflection chamber of the spectrometer. The ions travel in semi-circular paths in the deflection chamber before being detected.



(a) Draw a sketch of a positive ion passing through the velocity selector shown below, showing the directions of the fields and of the forces acting on the ion if the positive ion travels too slowly through the plates.

[3 marks]



(b) Ions travel in a straight line through the velocity selector when the electric and magnetic forces acting on them balance. Derive a simple formula for the speed of an ion travelling in a straight line through the velocity selector in terms of the Voltage, **V**, between the plates, the separation of the plates, **d**, and the magnetic field strength, **B**.

[3 marks]

(c) The charged plates in the velocity selector are 3.60 cm apart and have a potential difference of 540 V across them. The magnetic field is of strength 0.120 T. Calculate the speed of the ions selected to pass through slit S_2.

[3 marks]

(d) What is the mass of singly charged ions that reach a speed of 1.25×10^5 m/s when accelerated by a potential difference of 1630V? (Show working)

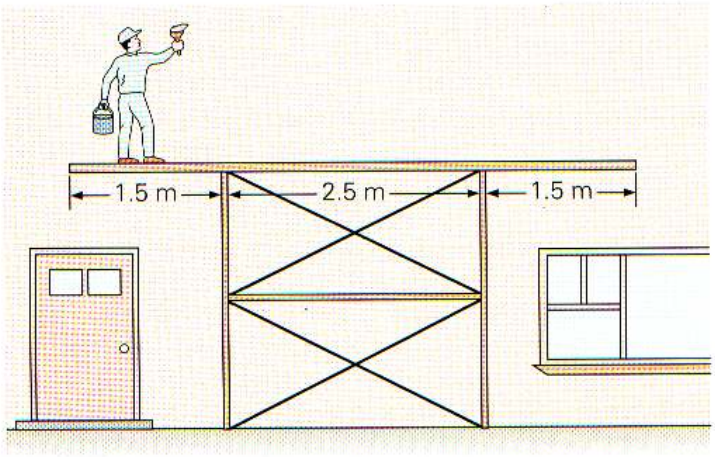
[2 marks]

(e) These singly ionised neon ions, of mass number 20, travel in an arc of a certain radius and strike the target as shown. Given that all ions move at the same speed in the mass spectrometer, calculate the distance 2r if they travel through the deflection chamber with its perpendicular magnetic field strength of 65.2 mT.

[3 mark]

4. (a) Whilst standing on a long board resting on a scaffold, a 70.0 kg painter paints the side of a house. If the mass of the board is 25.0 kg, how close to the end of the board can the painter stand without tipping?

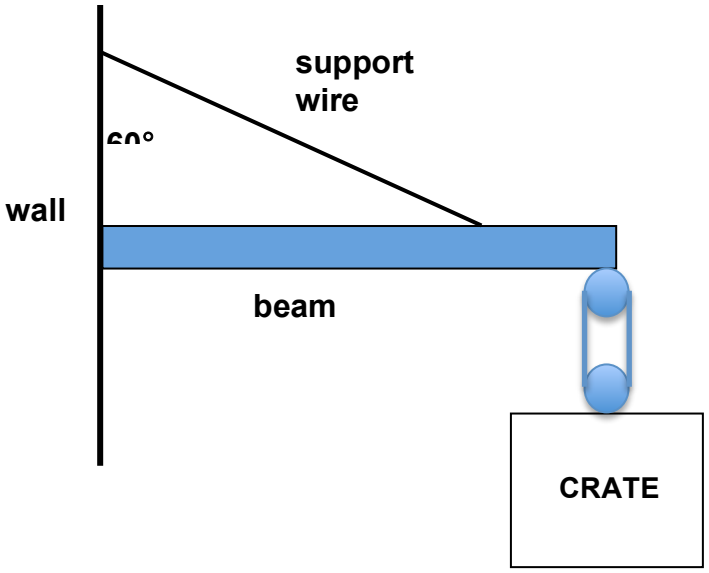
[3 marks]



(b) Suppose the board shown in the previous question was suspended from vertical ropes attached to each end instead of resting on scaffolding. If the painter stood 1.50 m from one end of the board, what would be the tension in the ropes?

[3 marks]

5. In a warehouse, a crate of mass 50.0 kg is being lifted by a pulley attached to the end of a uniform beam, which is held horizontally in place by a support wire, as shown in the diagram below. The beam has a mass of 10.0 kg and is 3.50 m in length, and is hinged firmly to a nearby wall. The support wire attaches to the beam 2.50 m from the wall



(a) Show on the diagram above all the forces acting on the beam.

[3 marks]

(b) What is the force exerted by the support wire on the beam?

[4 marks]

(c) What is the force exerted by the wall on the beam?
(State magnitude and direction)

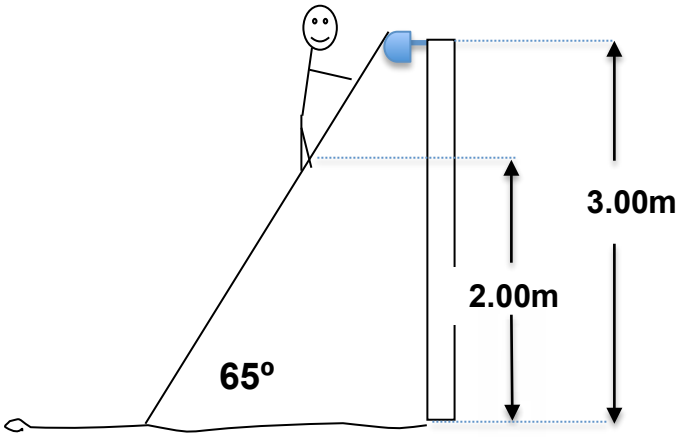
[5 marks]

Use for Exam

6. A ladder of mass 25.0kg rests against a smooth curved gutter such that the force exerted on the ladder is perpendicular to the ladder. The ladder makes an angle of 65.0^{o} to the ground and the gutter is 3.00m vertically above the ground. If a painter climbs the ladder so that they are 2.00m above the ground then:

(a) What force does the ladder exert against the gutter?

[4 marks]



(b) What force does the ground exert on the ladder?

[4 marks]

(c) What conditions are required for objects to be in a very stable equilibrium?

[2 marks]