Neap:

PHYSICS VCE UNITS 3&4
DIAGNOSTIC TOPIC TESTS 2017

TEST 2: HOW DO THINGS MOVE WITHOUT CONTACT? (II)

TOTAL 45 MARKS (45 MINUTES)

Student's Name: _____ Teacher's Name: _____

Directions to students

Write your name and your teacher's name in the spaces provided above.
Answer all questions in the spaces provided.

Question 1 (11 marks)

For this question

- mass of the Earth = 5.98×10^{24} kg
- mass of the International Space Station = 4.20×10^{5} kg
- Universal Gravitational Constant = 6.67×10^{-11} SI units
- radius of the Earth = 6.38×10^{6} m.

The International Space Station is in a circular orbit at an altitude of 400 km above the surface of the Earth.

a. Determine the radius of the orbit of the International Space Station. 1 mark

m

b. Determine the gravitational field strength of the Earth at the position of the International Space Station in its orbit. 2 marks

N kg^{-1}

c. Determine the weight of the International Space Station at its position in orbit about the Earth. 2 marks

N

d. Determine the period of the International Space Station in its orbit in minutes. 3 marks

min

e. Astronauts in the International Space Station float as they live and work. They experience weightlessness during their time in the craft.

Explain why they are weightless during this time. In your answer make reference to the terms **weight** and **normal reaction**. 3 marks

Question 2 (8 marks)

Figure 1 shows two coils of uniformly wound wire. Both coils have the same positive DC current passing through them. Point A is a point midway between the two coils.

Figure 1

a. Draw the resulting magnetic field vector at point A. 1 mark

b. Explain how you arrived at your answer to part **a.** 3 marks

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c. Explain the effect on your answer to part **a.** if one of the coils is rotated through 180°. 2 marks

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d. Explain the effect on your answer to part **a.** if the current in one of the coils is decreased. 2 marks

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Question 3 (4 marks)

Two negative charges, –Q and –2Q, are distances r and $2r$ from point X, as shown in Figure 2.

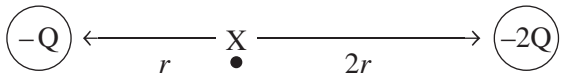

Figure 2

a. Show the direction of the resultant electric field at point X. 1 mark

b. Explain what happens to the magnitude and direction of the resultant field if the charge –Q is now placed at a distance $4r$ from point X. Show your working. 3 marks

Question 4 (3 marks)

A bundle of five 50 cm long wires are each carrying 2.0 A of DC current to the right in a uniform magnetic field of strength 9.0×10^{-2} T, as shown in Figure 3.

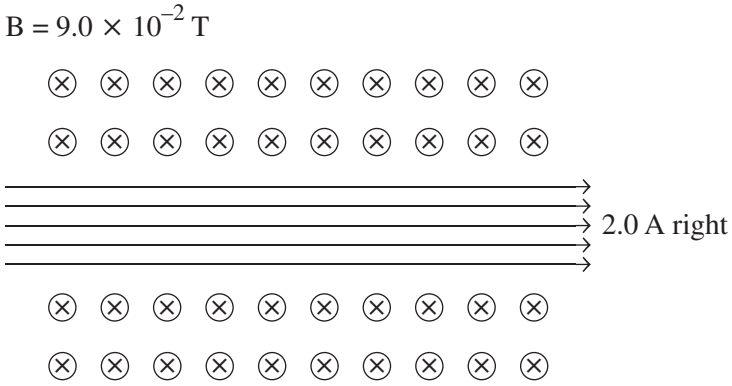

Figure 3

Calculate the magnitude of the magnetic force acting on the bundle of five wires carrying the current and determine the direction of the force.

N	direction

Question 5 (12 marks)

Figure 4 shows a schematic diagram for a simple DC motor. The coil is connected to a battery via a commutator and a switch.

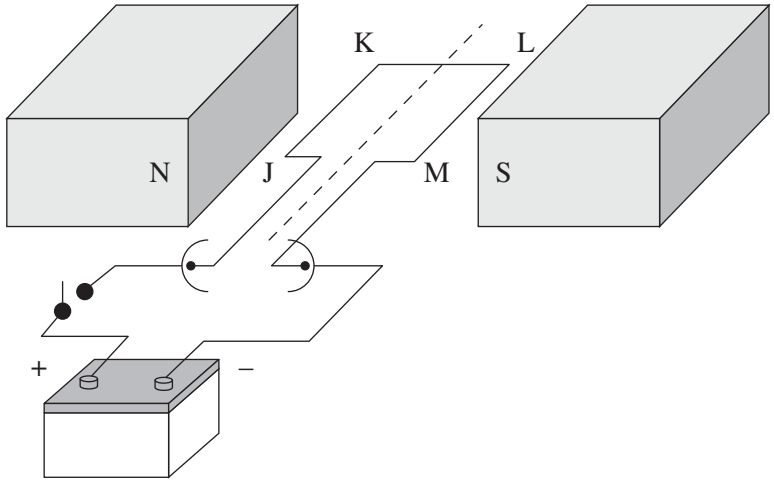

Figure 4

a. When the switch is closed, explain whether the coil turns clockwise or anticlockwise as seen from the front of the motor (near the battery). 3 marks

b. Explain how the commutator works and therefore its importance. 3 marks

c. State two simple ways in which the motor could be made to turn in the opposite direction. 2 marks

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The DC motor has 500 turns of wire, the current is 400 mA and the magnetic field is 0.50 T. The length of JK is 0.20 m and the length of KL is 0.05 m.

d. Calculate the magnitude of the force acting on the JK arm of the DC motor for the position of the coil shown in Figure 4. 2 marks

N

e. Calculate the magnitude of the force acting on the KL arm of the DC motor for the position shown in Figure 4. 2 marks

N

Question 6 (4 marks)

The linear accelerator SLAC can accelerate individual electrons to an energy of 8.0×10^{-9} J.

a. Determine the potential difference in V needed to achieve this energy. 2 marks

V

b. Determine the electric field strength in the chamber of the SLAC if it is 3.2 km long. 2 marks

V m^{-1}

Question 7 (3 marks)

Figure 5 shows a magnetic component section of a synchrotron particle accelerator. The electron beam curves inwards as a result of the magnetic field as shown.

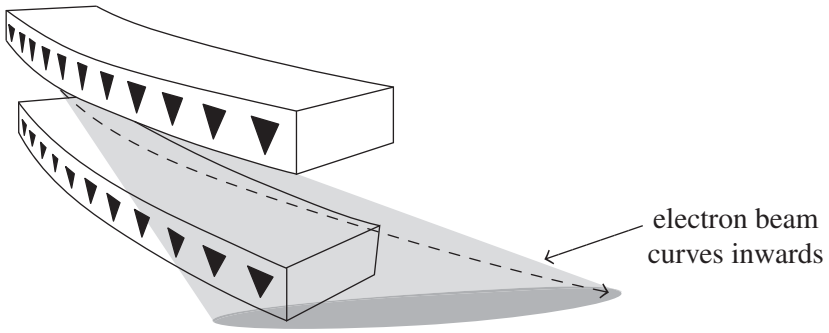

Figure 5

a. On Figure 5, show the direction of the magnetic field where the electron beam is. 1 mark

b. Explain how you arrived at your answer to part **a.** 2 marks

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