



VCE PHYSICS UNITS 3&4 [2020]

Unit 3 AOS 1 - How do things move without contact? - Topic Exam 2

YOUR NAME: Vishnu Prasad Sivakumar

STRUCTURE OF EXAM

Section A - Multiple Choice	4 questions	7 marks
Section B - Short Answer	10 questions	30 marks
		37 marks

WHEN YOU FINISH

Get your marks, and view solution videos that explain the answer to each question at:

edrolo.com.au/e2823

SECTION A – MULTIPLE CHOICE**Question 1** (1 mark)

Two masses have a gravitational force of 12 N between them.

If the distance between the masses is doubled, what would be the new gravitational force between them?

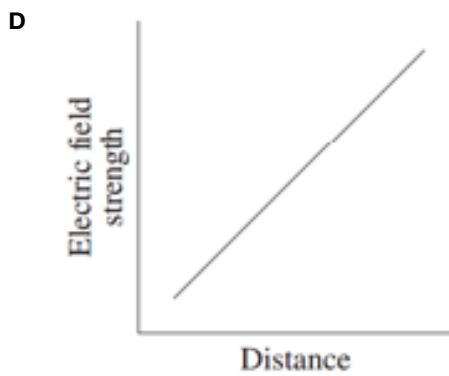
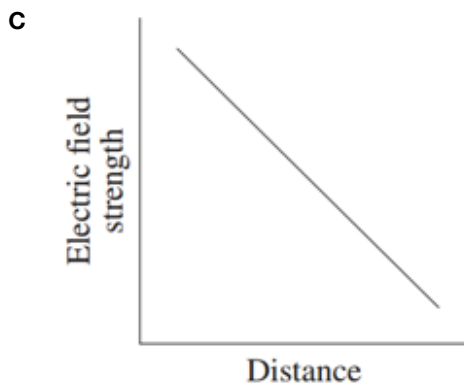
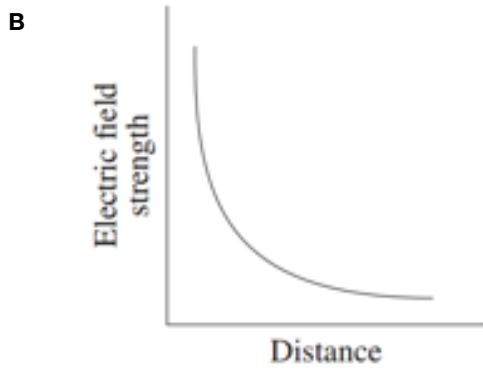
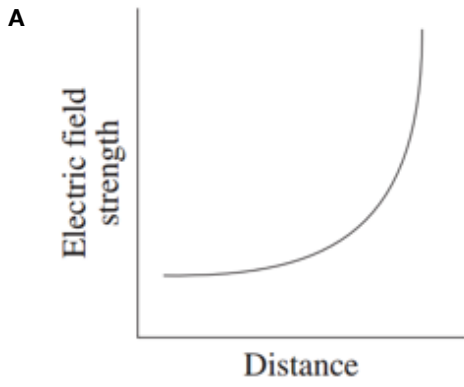
- A** 3 N
- B** 6 N
- C** 12 N
- D** 24 N

Question 2 (1 mark)

Two charged plates are initially separated by a distance as shown in the diagram.

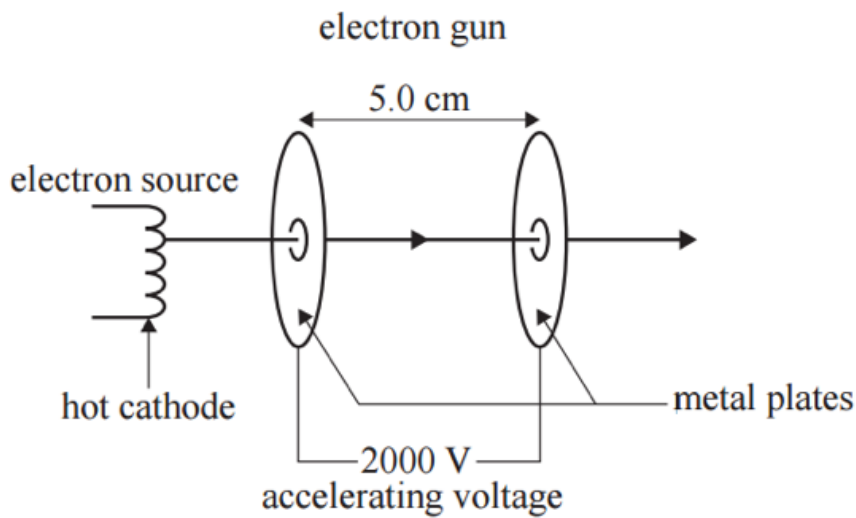


The potential difference between the plates remains constant. Which of the graphs best represents the change in electric field strength as the distance between the two plates is increased?



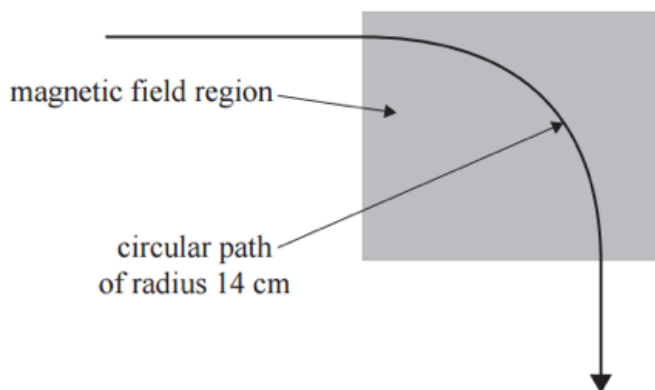
Question 3 (3 marks)

An electron gun is used to inject electrons into the linac of a synchrotron. Figure below shows a schematic diagram of the electron gun. The mass of an electron is 9.1×10^{-31} kg and the charge on an electron is 1.6×10^{-19} C.



The electron is accelerated by an electric field generated by a voltage of 2000 V applied across the two plates. The plates are 5.0 cm apart.

An electron leaves the electron gun travelling at $2.7 \times 10^7 \text{ ms}^{-1}$. The electron enters a uniform magnetic field and moves in a circular path of radius 14 cm, as shown in Figure 2.

**Question 3.a** (1 mark)

Which of the following is the best estimate of the magnitude of the electric force acting on an electron when it is between the plates?

- A $1.6 \times 10^{-17} \text{ N}$
- B $6.4 \times 10^{-17} \text{ N}$
- C $6.4 \times 10^{-15} \text{ N}$
- D $4.0 \times 10^4 \text{ N}$

Question 3.b (1 mark)

Which of the following is the best estimate of the magnitude of the strength of the magnetic field?

- A 1.1 mT
- B 0.11 T
- C 910 T
- D 30kT

Question 3.c (1 mark)

Which of the following best describes the direction of the magnetic field?

- A down the page
- B out of the page
- C up the page
- D into the page

Question 4 (2 marks)

The planet Mars has a mass of 6.4×10^{23} kg, which is approximately 1/10 that of Earth, and its radius is approximately half that of Earth

Which of the following gives the best value for the acceleration due to gravity at the surface of Mars?

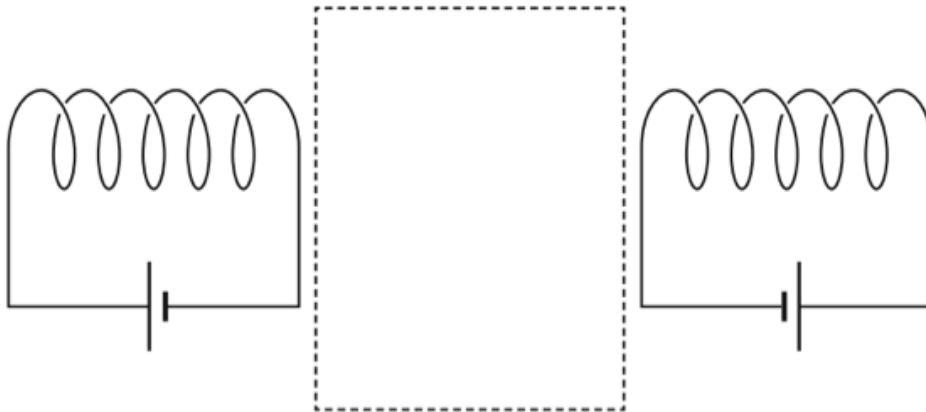
- A 1ms^{-2}
- B 2.5ms^{-2}
- C 4ms^{-2}
- D 5ms^{-2}

SECTION B – SHORT ANSWER**Question 1**

2 marks

Two solenoids are shown in figure below. Current is flowing through their coils and both of them are generating magnetic fields. Their combined field is much greater than Earth's field.

Sketch at least four field lines in the space enclosed by the dashed rectangle. Mark the direction of each field line that you draw.

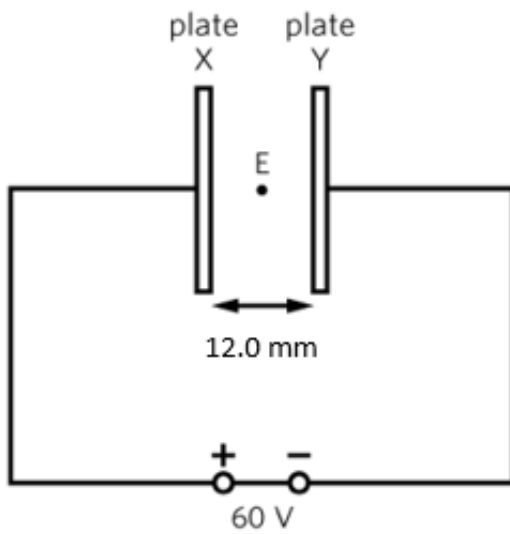


Please use pen and paper to complete your response.

Question 2

3 marks

Two conducting plates X and Y are positioned as shown so that they are separated by a distance of 12.0 mm in air. A 60 V DC supply is connected.



What would be the magnitude and direction of the electric field strength at the mid-point between the plates?

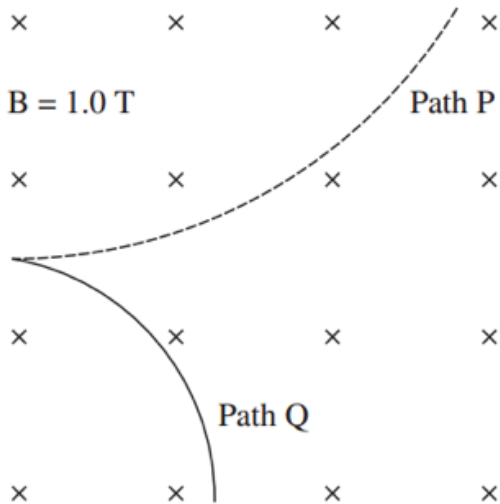
Question 3

2 marks

The electric force between 2 identically charged objects is a repulsive force equal to 9.2×10^{-7} N. If these objects are separated by 3 mm of air, find the size of the charge of one of the objects. Take Coulomb's Law constant to be $9.0 \times 10^9 \text{ Nm}^2 \text{ C}^{-2}$.

Question 4 (3 marks)

The diagram shows the paths taken by two moving charged particles when they enter a region of uniform magnetic field.

**Question 4.a**

1 mark

Why do the paths curve in different directions?

Question 4.b

2 marks

How do the properties of a particle affect the radius of curvature of its path in a uniform magnetic field?

Question 5 (3 marks)

In an experiment an electron is fired at a velocity of

$2.1 \times 10^6 \text{ ms}^{-1}$ into a magnetic field of strength 1.3 T . In the first instance the electron is fired parallel to the field and in the second instance it is fired perpendicularly to the field.

Question 5.a

1 mark

Calculate the size of the force acting on the electron if **fired parallel to the field**.

Question 5.b

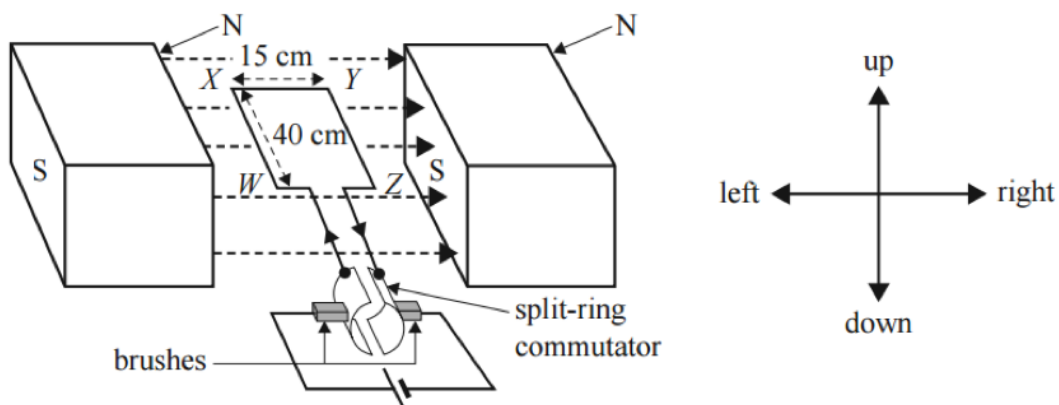
2 marks

Calculate the size of the force acting on the electron if fired perpendicularly to the field.

Question 6 (4 marks)

A model DC motor using permanent magnets is shown in Figure 27. The coil of the motor is formed from 75 turns of wire. Each turn is rectangular, having a length of 40 cm (sides WX and YZ) and a width of 15 cm (sides XY and WZ).

The magnetic field is uniform and has a value of 0.020 T. The coil can rotate freely between the magnets. The axis of the motor and the direction of the magnetic field are shown.

**Figure 27****Question 6.a**

2 marks

Describe the direction of the forces on all four sides of the coil (WX, XY, YZ, ZW). Assume that the coil is in the horizontal position and the current direction is as shown in Figure 27. Use the words 'up', 'down', 'left', 'right' or 'no force'.

WX:

XY:

YZ:

ZW:

Question 6.b

2 marks

What is the magnitude of the force on the side **WX** of the 75-turn coil when the coil is horizontal and the current is 2.0 A?

Question 7

2 marks

An astronaut is sent out to repair part of the International Space Station and they seemingly float alongside the station to the site of the repair. An image of this space walk is shown to a class and one student explains to the class that the **astronaut is floating** because they are beyond the Earth's gravitational field so that there are **no forces acting** on them. Explain whether this statement is correct paying specific attention to the terms in bold.

Question 8

3 marks

The planet Mars has a mass of 6.4×10^{23} kg, which is approximately 1/10 that of Earth, and its radius is approximately half that of Earth

The Mars probe that was launched in August 2005 is now orbiting Mars in an orbit with an average radius of 3.00×10^7 m (Figure 7).

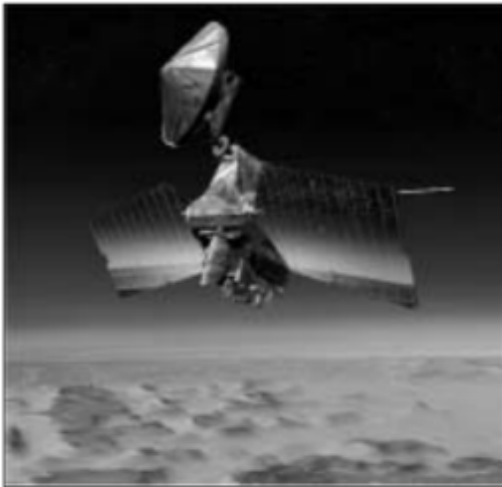


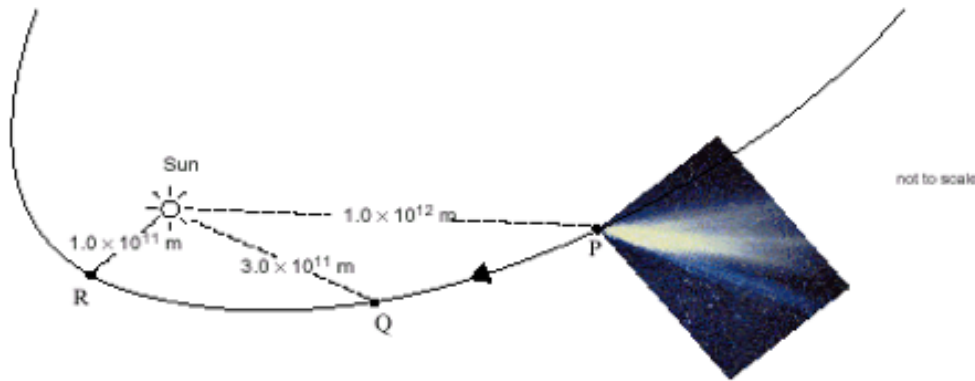
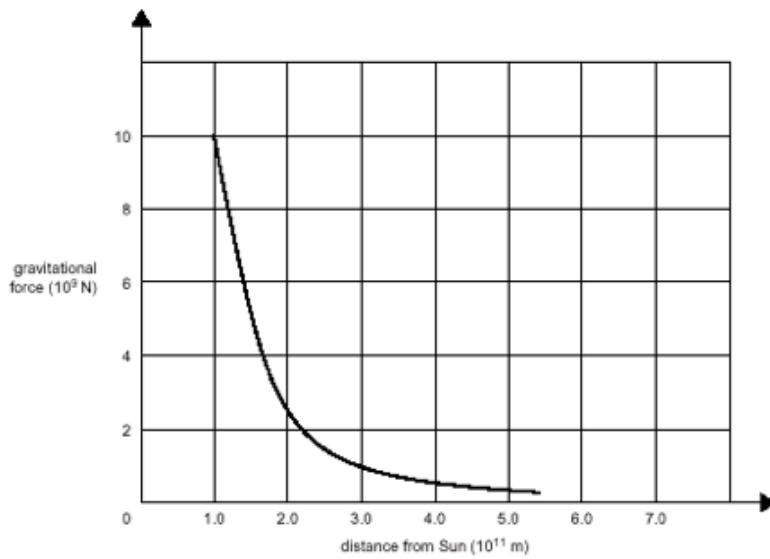
Figure 7

What is the period of the orbit in seconds?

Question 9

3 marks

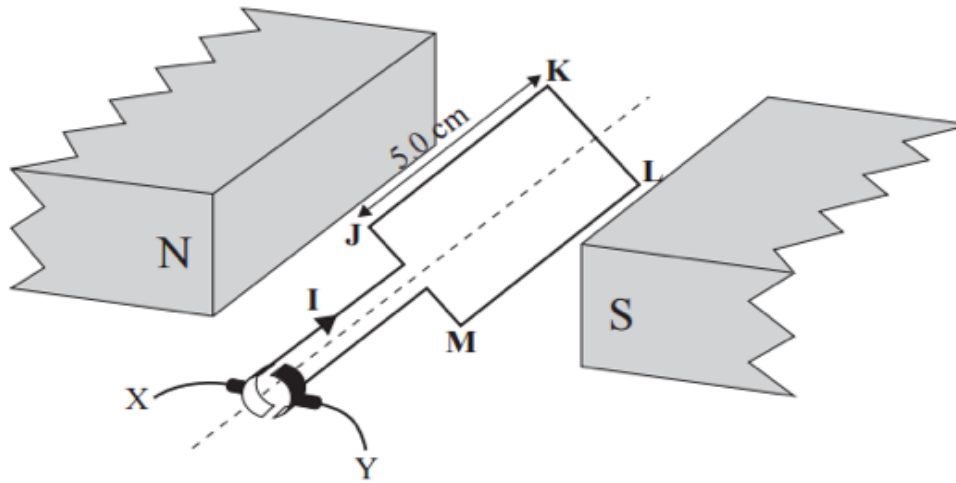
Figure 1 shows a graph of the gravitational force that the Sun exerts on Halley's comet as a function of the distance of the comet from the Sun.



Estimate the potential energy lost by the comet as it travels from Q (3.0×10^{11} m from the Sun), to R (1.0×10^{11} m from the Sun). Working must be shown.

Question 10 (5 marks)

Figure 3 shows a schematic of a DC electric motor. The motor has a rectangular coil, JKLM, of 50 turns. The permanent magnets provide a uniform magnetic field of 0.30 T in the region of coil JKLM. The commutator with contacts X and Y is connected to a source of constant DC current.

**Figure 3****Question 10.a**

3 marks

Explain the role of the commutator in the operation of the motor.

Question 10.b

2 marks

A current of 6.0 A is flowing in the 50-turn rectangular coil. The length of side JK is 5.0 cm. Calculate the magnitude of the magnetic force acting on side JK when it is in the position shown in Figure 3.
