2025 Complete VCE Education

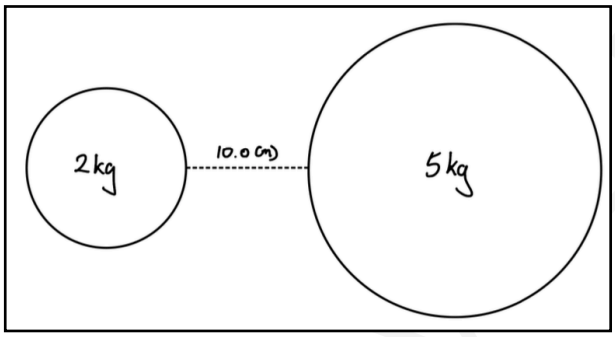
Unit 3 AOS 2 Diagnostic Quizzes

Quiz 1: Gravitational Fields

Q1) What does the density of gravitational field lines indicate?

A. The direction of a field
B. The strength of a field
C. The type of field
D. The distance from field source

Q2) Two point masses of 2 kg and 5 kg, shown below, are separated by a distance of 10.0 m. Calculate the gravitational force on the 2 kg mass due to the gravitational field of the 5 kg mass.

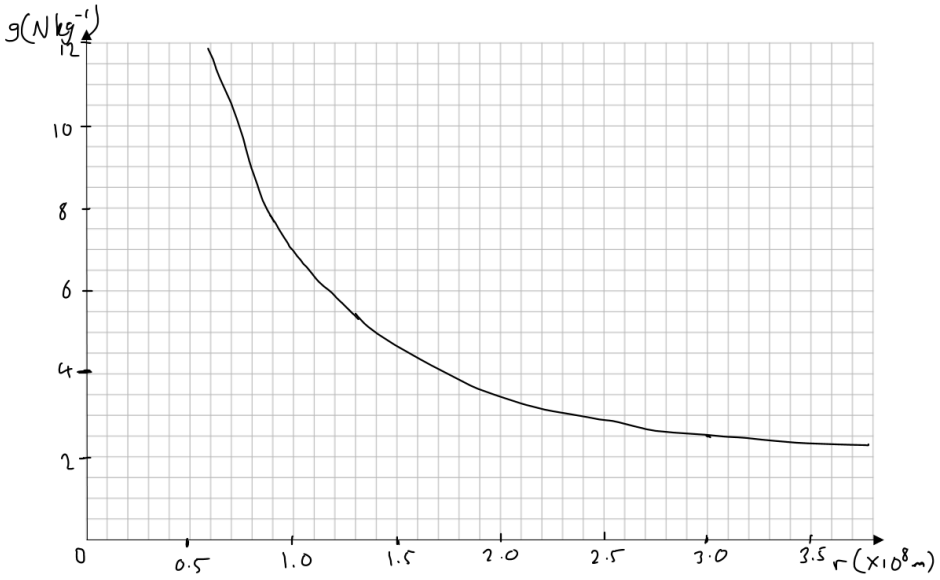


A. $6.67 \times 10^{-11}\ N$
B. $6.67 \times 10^{-12}\ N$
C. $5.34 \times 10^{-11}\ N$
D. $3.49 \times 10^{-11}\ N$

Q3) Johnathan is wearing a jet pack which allows him to fly to great heights. He starts at the surface of the Earth where the gravitational acceleration he experiences is $9.81\ m\ s^{-2}$. He then flies to point X which is 3R metres from the centre of the Earth, where R is the radius of the Earth. What is the magnitude of the gravitational acceleration that Johnathan experiences at point X?

A. $9.81\ m\ s^{-2}$
B. $3.27\ m\ s^{-2}$
C. $1.09\ m\ s^{-2}$
D. $0.61\ m\ s^{-2}$

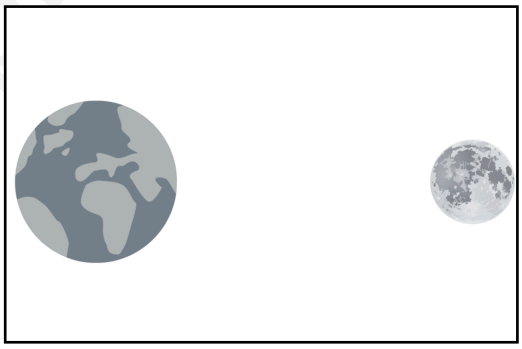
Q4) A graph of gravitational field strength versus distance from the centre of a planet is shown below.



Calculate the approximate change in gravitational potential energy as an 11 tonne spaceship moves from 1.0 x 10^8 m to 2.0 x 10^8 m above the centre of the planet.

A. 5.3 x 10^8 J
B. 3.9 x 10^{12} J
C. 5.8 x 10^{12} J
D. 7.7 x 10^{12} J

Q5) The gravitational fields of the Earth and the Moon interact to form a net gravitational field between them. A point exists where the gravitational field lines cancel each other out, resulting in the net gravitational field strength being 0. This point is known as the Lagrange point. Which one of the following statements regarding the Lagrange point is correct?



A. The Lagrange point is closer to the Moon than the Earth
B. The Lagrange point is closer to the Earth than the Moon
C. The Lagrange point is equidistant from the Earth and the Moon
D. None of the above

Quiz 2: Satellite Motion

Q1) What force provides the centripetal force required for a satellite to orbit a planet?

A. Frictional force
B. Thrust force
C. Electric force
D. Gravitational force

Q2) A geostationary satellite is a satellite which is always above a fixed point on the surface of the Earth. Which one of the following is a condition of a geostationary satellite?

A. A geostationary satellite must have a period greater than 24 hours
B. A geostationary satellite must be always above the equator
C. If the Earth rotates clockwise around its axis, then the geostationary satellite must orbit in an anticlockwise direction
D. A geostationary satellite must always be above the poles of the Earth

Q3) A satellite orbits the Earth from a radial distance of $2.64 \times 10^7\ m$. Which of the following is closest to the orbital speed of the satellite? HINT: Use the VCAA formula sheet to obtain the mass of the Earth.

A. 3880 m s^{-1}
B. 4500 m s^{-1}
C. 5000 m s^{-1}
D. 2540 m s^{-1}

Q4) Two satellites, A and B, orbit the same planet. Satellite A has an orbital radius of r and a period of T. Satellite B has an orbital radius of 2r. What is the period of satellite B?

A. 2T
B. 3T
C. 2.82T
D. 4.5T

Q5) A 800 kg satellite is orbiting Earth. The orbital period of the satellite is 42 hours. Calculate the altitude of the satellite above Earth's surface.

A. 1.2 x 10^6 m
B. 7.5 x 10^6 m
C. 5.5 x 10^7 m
D. 6.1 x 10^7 m

Quiz 3: Electric Fields

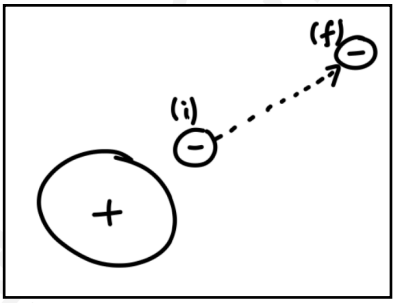
Q1) A charge of +2 C is placed in an electric field of strength 5 N/C. What is the magnitude of the electric force experienced by the charge?

A. 10 N
B. 0.4 N
C. 2.5 N
D. 20 N

Q2) Two point charges, q_1 and q_2 are separated by a distance r. An electric force F exists between them. What is the electric force between them if the distance is halved?

A. $2F$
B. $\frac{F}{2}$
C. $4F$
D. $8F$

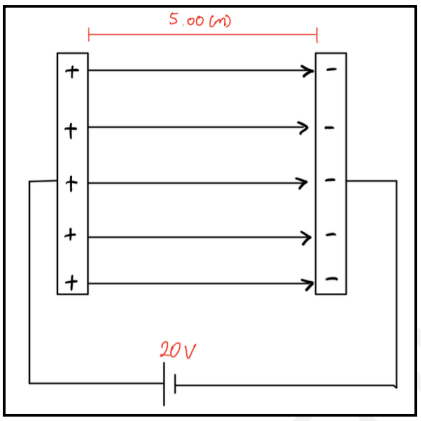
Q3) The below diagram illustrates an electron moving from point (i) to point (f) away from a proton. Which of the following statements is true?



A. The electric field strength due to the positive charge at point (f) is greater than the electric field strength at point (i)
B. The electric field strength decreases linearly from point (i) to point (f)
C. The electric potential energy of the electron increases from point (i) to point (f)
D. The electric field of the proton is uniform

The following applies to question 4 and question 5.

Q4) A proton of mass 1.67 x 10^{-27} kg is released at rest from a positive plate in a 20 V electric field. It travels a distance of 5.00 m towards the negative plate. What is amount of electric potential energy the proton loses?



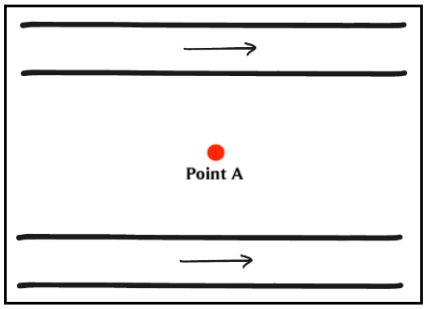
A. $3.2 \times 10^{-18}\ J$
B. $4.0 \times 10^{-18}\ J$
C. $3.2 \times 10^{-19}\ J$
D. $5.0 \times 10^{-19}\ J$

Q5) Which of the following is closest to the final speed of the proton as it reaches the negative plate?

A. 2.0 x 10^{4} m s^{-1}
B. 2.4 x 10^{4} m s^{-1}
C. 6.2 x 10^{4} m s^{-1}
D. 6.9 x 10^{4} m s^{-1}

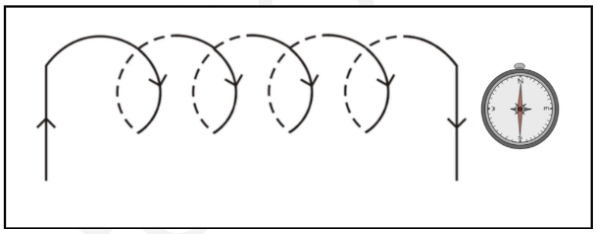
Quiz 4: Magnetic Fields

Q1) Two parallel wires are shown below. The magnetic field strength of the top wire at point A is 10 T whereas the magnetic field strength of the bottom wire at point A is 12 T. What is the net magnetic field strength at point A?



A. 22 T into the page
B. 6 T into the page
C. 2 T into the page
D. 2 T out of the page

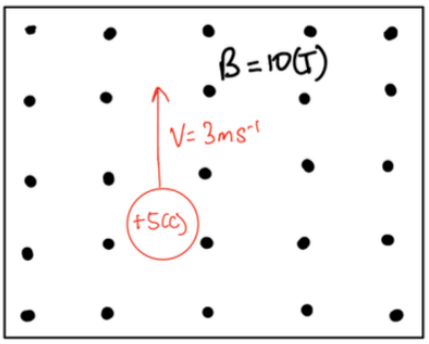
Q2) A compass is positioned next to a solenoid, as shown below. Ignoring the effects of the Earth's magnetic field, which way would the compass needle point?



A. N
B. E
C. S
D. W

The following applies to question 3 and question 4.

A positive charge of +5 C travels in a uniform magnetic field of 10 T at a speed of 3 m s^{-1}.



Q3) What is the magnitude of the magnetic force acting on the charge?

A. 100 N
B. 200 N
C. 150 N
D. 300 N

Q4) For the given conditions, the radius of the circular path is 0.1 cm. If the speed of the charge is doubled, what is the new radius of the path given an unchanged magnetic field?

A. 0.3 cm
B. 0.5 cm
C. 0.2 cm
D. 0.4 cm

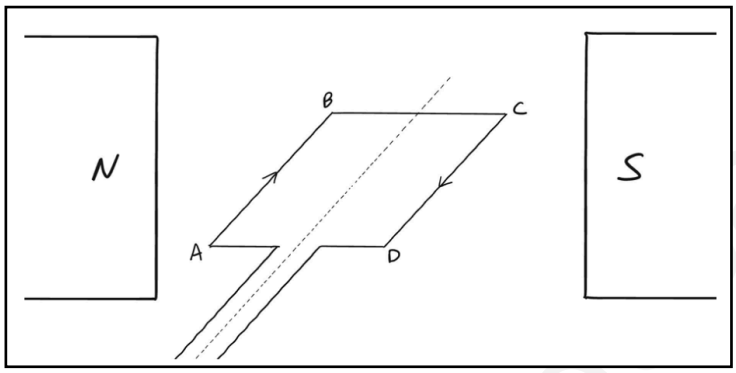
Q5) An electron is travelling parallel to a magnetic field of magnitude 5.0 T, at a speed of 4000 m s^{-1}. Which of the following is the magnitude of the magnetic force acting on the electron?

A. 0 N
B. 6.4 x 10^{-16} N
C. 3.2 x 10^{-15} N
D. 4.6 x 10^{-9} N

Quiz 5: DC Motors

The following applies to questions 1-3.

A DC motor of 10 turns and 2 m length is inside a magnetic field with a magnetic field strength of 0.01 T, as shown below.



Q1) Given that a 2 A current flows through the coil, what is the magnitude of the magnetic force acting on side CD of the coil due to the field?

A. 4 N
B. 5 N
C. 0.4 N
D. 0.5 N

Q2) The DC motor above is now updated with 20 turns of wire. The loop will now:

A. Rotate at a faster rate
B. Rotate at the same rate
C. Rotate at a slower rate
D. No longer rotate

Q3) The DC motor is connected to a split-ring commutator. When current is supplied to the motor, it begins to rotate.

Which of the following statements is true?

A. Side AB experiences an upward force.
B. Mechanical energy is converted to electric potential energy during the operation.
C. Side BC experiences no magnetic force.
D. The torque of the motor is a maximum at the vertical position.

Q4) Which of the following best describes the purpose of a split ring commutator in a DC motor?

A. To maintain a constant connection between the coil and the external circuit.
B. To reverse the direction of the current in the coil every half rotation.
C. To reverse the direction of the current in the coil every quarter rotation.
D. To speed up the rotation of the motor

Q5) Which of the following statements best describes what will happen if a DC motor is connected to slip rings instead of a split-ring commutator? Assume that the plane of the coil begins parallel to the magnetic field.

A. The coil continuously rotates in the same direction.
B. The coil will remain stationary.
C. The coil will rotate 90 degrees and then the direction of rotation will reverse.
D. The coil will rotate 90 degrees and oscillate about the vertical position before stopping.

Answers:

Quiz 1 (Gravitational Fields):

Question	Answer	Notes
1	B	The density of gravitational field lines reflects the strength of the gravitational field. The denser (closer together) the field lines, the stronger the field.
2	B	Use the formula $F_g = Gm_1m_2/r^2$.
3	C	The magnitude of gravitational acceleration (or gravitational field) is inversely proportional to the distance from the centre squared. Therefore, as the distance from the centre is tripled, the magnitude of gravitational acceleration will be 1/9th of the original.
4	C	The area under the graph is the change in gravitational energy per kilogram, since the y-axis is gravitational field (which is in N kg^{-1}). Therefore, to find the change in gravitational potential energy, you need to find the area under the graph (either by counting squares or using a trapezium to approximate the area), and then multiply the area by mass.
5	A	At the midpoint, the gravitational field strength due to Earth is greater than that due to the moon, due to Earth's greater mass. Thus, at the midpoint the net gravitational field is to the left. Therefore, the point where the gravitational fields are equal in magnitude (ie. cancel each other out) must be closer to the moon than Earth.

Quiz 2 (Satellite Motion):

Question	Answer	Notes
1	D	As a satellite orbits a planet, the gravitational force on the satellite acts towards the centre of the planet (centre of the circle), at right angles to the satellite's velocity. Therefore, it acts as the centripetal force.
2	B	A geostationary point must remain vertically above a fixed position on Earth. This will only be possible if: - The satellite is always above the equator - The period of rotation of the satellite is the same as the period of rotation of the Earth (ie. 24 h). - The satellite revolves in the same direction as the direction of Earth's rotation.
3	A	Use the derived formula v=root(GM/r). This comes from equating the centripetal force (mv^2/r) and the gravitational force (GMm/r^2)

4	C	Use Kepler's Third Law: r^3/T^2 = constant. Since both satellites are orbiting the same planet, the constant must be the same for both satellites. Therefore, equate the ratio r^3/T^2 for both planets and solve for the period of satellite B.
5	C	Use the derived formula $r^3/T^2=GM/4\pi^2$, and solve for r (distance from centre of Earth). Remember to convert T to hours. However, the question is asking for the altitude (above Earth's surface), so the radius of Earth needs to be subtracted from r.

Quiz 3 (Electric Fields):

Question	Answer	Notes
1	A	Use the formula F=qE.
2	C	The electric force is inversely proportional to the distance (between the charges) squared. If the distance is halved, then the electric force must be 4 times the original.
3	C	The electric field strength must be greater closer to the positive charge than away from it. However, it will not decrease linearly from (i) to (f) as electric field strength is inversely proportional to the distance squared. Furthermore, the electric field is non-uniform since the strength decreases with distance. The electric potential energy of the electron will increase from (i) to (f) as it is being moved opposite to the direction of the electric force.
4	A	Use the formula W=qV.
5	C	Use the formula $W=\Delta E_k=1/2\ mv^2$ - 0 (begins at rest), and solve for v.

Quiz 4 (Magnetic Fields):

Question	Answer	Notes
1	D	Use the right hand grip rule to determine the magnetic field directions due to both wires at point A. At point A, the magnetic field due to the top wire is 10 T into the page, and the magnetic field due to the bottom wire is 12 T out of the page. The vector sum of these will be 12 - 10 = 2 T out of the page.
2	B	Using the right hand coil rule, the magnetic field within the solenoid will be to the right. This will create a magnetic north pole on the right side of the solenoid (left of the compass). However, the north pole of the compass needle will be repelled by the north pole of the solenoid, so it will point east (away from the solenoid).
3	C	Use the formula F=qvB, since the charge is moving perpendicular to the magnetic field.

4	C	According to the formula r=mv/qB, the radius is proportional to speed (since other variables are constant). Therefore, if the speed is doubled, the radius of the circular path will be doubled.
5	A	When a charge is travelling parallel to a magnetic field, the magnetic force on that charge is zero (common trap). The formula F=qvB should only be used if the charge is travelling perpendicular to the magnetic field.

Quiz 5 (DC Motors):

Question	Answer	Notes
1	C	Use the formula F=nIlB, since the direction of current is perpendicular to the magnetic field.
2	A	When the number of turns (n) increases, the magnitude of magnetic force on each side of the loop will increase, so the loop will rotate faster.
3	C	- Using the right hand palm rule, side AB experiences a downward force and side CD experiences an upward force. - Since current is supplied to cause the coil to rotate, electric potential energy is converted to mechanical energy. - At the vertical position, the angle between the magnetic force and the radial distance is zero. Therefore, the torque at the vertical position is zero. - Side BC does not experience a magnetic force since the direction of current is parallel to the magnetic field.
4	B	A split-ring commutator reverses the direction of current every half turn, when the plane of the coil becomes perpendicular to the magnetic field. This reverses the direction of magnetic force on each side of the coil, which maintains continuous rotation in the same direction.
5	D	The coil will rotate as normal for 90 degrees, as the directions of magnetic force on both sides of the coil will be opposite, creating a net torque. Unlike commutators, slip rings do not reverse the direction of current, maintaining a constant connection with the external circuit. Without a reversal of current direction at the vertical position, the coil cannot continue rotating after 90 degrees. Instead, it will oscillate about the vertical position before coming to a stop (as the torque is zero).