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Class 12
Physics

Chapter 19

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By Misbah

FBISE Physics — Class 12

Domain E: Electricity & Magnetism

Complete MCQs & Short Questions with Answers

Section A: Multiple Choice Questions (40 MCQs)

Each question has four options. The correct answer is highlighted in green.

Q1	**Electric potential at a point is defined as work done per unit positive charge in bringing a test charge from:** A) that point to infinity **B) infinity to that point** C) origin to that point D) that point to origin	**Correct Answer:** (B) infinity to that point *Topic: Electric Potential*
Q2	**The electric potential due to a point charge q at distance r is given by:** A) $V = q/(4\pi\varepsilon_0 r^2)$ **B) $V = q/(4\pi\varepsilon_0 r)$** C) $V = 4\pi\varepsilon_0 q/r$ D) $V = qr/(4\pi\varepsilon_0)$	**Correct Answer:** (B) $V = q/(4\pi\varepsilon_0 r)$ *Topic: Electric Potential*
Q3	**The electric field at a point is equal to the:** A) positive potential gradient at that point **B) negative of the potential gradient at that point** C) second derivative of potential D) square of potential gradient	**Correct Answer:** (B) negative of the potential gradient at that point *Topic: Electric Field & Potential*
Q4	**The electric potential energy of two point charges q and Q separated by r is:** A) $Ep = qQ/(4\pi\varepsilon_0 r^2)$ **B) $Ep = qQ/(4\pi\varepsilon_0 r)$** C) $Ep = 4\pi\varepsilon_0 qQ/r$ D) $Ep = qQ \cdot r/(4\pi\varepsilon_0)$	**Correct Answer:** (B) $Ep = qQ/(4\pi\varepsilon_0 r)$ *Topic: Potential Energy*
Q5	**Capacitance is defined as:** **A) charge per unit voltage** B) voltage per unit charge C) energy stored per unit charge D) charge per unit electric field	**Correct Answer:** (A) charge per unit voltage *Topic: Capacitance*
Q6	**Which of the following does NOT affect the capacitance of a parallel plate capacitor?** A) Area of plates B) Distance between plates C) Nature of dielectric **D) Charge on the plates**	**Correct Answer:** (D) Charge on the plates *Topic: Capacitance*
Q7	**For capacitors in series, the combined capacitance is:**	**Correct Answer:**

	A) greater than any individual capacitor B) equal to the sum of individual capacitances **C) less than the smallest individual capacitance** D) equal to the product of capacitances	(C) less than the smallest individual capacitance *Topic: Capacitors in Series*
Q8	**For capacitors in parallel, the combined capacitance is:** A) less than the smallest capacitance **B) equal to the sum of individual capacitances** C) equal to product divided by sum D) equal to the smallest capacitance	**Correct Answer:** (B) equal to the sum of individual capacitances *Topic: Capacitors in Parallel*
Q9	**The energy stored in a capacitor is given by:** A) U = QV **B) U = ½QV** C) U = 2QV D) U = QV^2	**Correct Answer:** (B) U = ½QV *Topic: Energy in Capacitor*
Q10	**The energy stored in a capacitor can also be written as:** A) U = Q^2/C **B) U = $Q^2/2C$** C) U = $2Q^2/C$ D) U = Q/2C	**Correct Answer:** (B) U = $Q^2/2C$ *Topic: Energy in Capacitor*
Q11	**Which expression also gives energy stored in a capacitor?** A) U = ½CV B) U = CV^2 **C) U = ½CV^2** D) U = 2CV	**Correct Answer:** (C) U = ½CV^2 *Topic: Energy in Capacitor*
Q12	**During the discharge of a capacitor through a resistor, the charge Q at time t is given by:** A) $Q = Q_0(1 - e^{(-t/RC)})$ **B) $Q = Q_0 e^{(-t/RC)}$** C) $Q = Q_0 e^{(t/RC)}$ D) $Q = Q_0 \ln(t/RC)$	**Correct Answer:** (B) $Q = Q_0 e^{(-t/RC)}$ *Topic: Capacitor Discharge*
Q13	**The time constant τ for a capacitor–resistor circuit equals:** A) R/C B) C/R **C) RC** D) 1/RC	**Correct Answer:** (C) RC *Topic: Capacitor Discharge*
Q14	**After one time constant, the charge on a discharging capacitor reduces to approximately:** A) 0% **B) 37%** C) 63%	**Correct Answer:** (B) 37% *Topic: Capacitor Discharge*

by fairy (Misbah)

	D) 50%	
Q15	**When a capacitor discharges, the current follows $x = x_0 \exp(-t/RC)$. Here x_0 represents:** A) value of x at t = τ **B) initial value of x at t = 0** C) final value of x D) value at t = RC/2	**Correct Answer:** (B) initial value of x at t = 0 *Topic: Capacitor Discharge*
Q16	**On a graph of charge vs time for a discharging capacitor, the curve is:** A) a straight line with negative slope B) a straight line with positive slope **C) an exponential decay** D) a parabola	**Correct Answer:** (C) an exponential decay *Topic: Capacitor Discharge*
Q17	**Which quantity does NOT decay exponentially during capacitor discharge?** A) Charge B) Current C) Voltage **D) Resistance**	**Correct Answer:** (D) Resistance *Topic: Capacitor Discharge*
Q18	**The energy stored in a capacitor can be found from a potential–charge graph by:** A) finding the gradient **B) finding the area under the curve** C) finding the y-intercept D) squaring the gradient	**Correct Answer:** (B) finding the area under the curve *Topic: Energy from Area*
Q19	**In a flash gun, a capacitor is used because it can:** A) store charge indefinitely **B) release a large amount of energy very quickly** C) reduce voltage fluctuations D) increase resistance	**Correct Answer:** (B) release a large amount of energy very quickly *Topic: Uses of Capacitors*
Q20	**Which household appliance uses capacitors for starting its motor?** A) Electric iron **B) Electric fan** C) Incandescent bulb D) Electric kettle	**Correct Answer:** (B) Electric fan *Topic: Uses of Capacitors*
Q21	**Capacitors are used in rectification circuits to:** A) increase voltage **B) smooth out the DC output** C) store charge permanently D) reduce current	**Correct Answer:** (B) smooth out the DC output *Topic: Uses of Capacitors*
Q22	**Ion channels in cell membranes are proteins that:** A) produce ATP	**Correct Answer:** (B) allow specific ions to pass through *Topic: Bioelectricity*

	B) allow specific ions to pass through C) destroy pathogens D) generate hormones	
Q23	**When a cell is stimulated, positive charges enter through open ion channels making the inside:** A) negatively charged B) neutral **C) positively charged** D) unchanged	**Correct Answer:** (C) positively charged *Topic: Bioelectricity*
Q24	**Electrical pulses generated in neurons are called:** A) synaptic potentials **B) action potentials** C) resting potentials D) threshold potentials	**Correct Answer:** (B) action potentials *Topic: Bioelectricity*
Q25	**Electrophorus Electricus (electric eel) generates electric shocks through:** A) external batteries **B) internal biological mechanisms acting as batteries** C) stored static charge D) chemical synthesis of electricity	**Correct Answer:** (B) internal biological mechanisms acting as batteries *Topic: Bioelectricity*
Q26	**Electroreception is the ability to detect:** A) magnetic fields only **B) weak naturally occurring electrostatic fields** C) infrared radiation D) gravitational fields	**Correct Answer:** (B) weak naturally occurring electrostatic fields *Topic: Bioelectricity*
Q27	**In AC circuits, the peak voltage V_0 and rms voltage Vrms are related by:** A) $V_{rms} = V_0$ B) $V_{rms} = 2V_0$ **C) $V_{rms} = V_0/\sqrt{2}$** D) $V_{rms} = V_0\sqrt{2}$	**Correct Answer:** (C) $V_{rms} = V_0/\sqrt{2}$ *Topic: AC Circuits*
Q28	**The frequency of AC mains supply in Pakistan is:** **A) 50 Hz** B) 60 Hz C) 100 Hz D) 25 Hz	**Correct Answer:** (A) 50 Hz *Topic: AC Circuits*
Q29	**The SI unit of capacitance is the farad (F). 1 F is equal to:** A) 1 C·V **B) 1 C/V** C) 1 V/C D) 1 J/C	**Correct Answer:** (B) 1 C/V *Topic: Capacitance*

Q30	**The work done W in bringing charge Q to a point of potential V is:** A) $W = V/Q$ B) $W = Q/V$ **C) $W = QV$** D) $W = Q^2V$	**Correct Answer:** (C) $W = QV$ *Topic: Electric Potential*
Q31	**If the electric potential is the same throughout a region, the electric field in that region is:** A) maximum B) minimum but not zero **C) zero** D) undefined	**Correct Answer:** (C) zero *Topic: Electric Field & Potential*
Q32	**Three capacitors of capacitance C each are connected in series. The equivalent capacitance is:** A) 3C **B) C/3** C) C D) 2C	**Correct Answer:** (B) C/3 *Topic: Capacitors in Series*
Q33	**Three capacitors of capacitance C each are connected in parallel. The equivalent capacitance is:** A) C/3 B) C **C) 3C** D) 2C	**Correct Answer:** (C) 3C *Topic: Capacitors in Parallel*
Q34	**Increasing the resistance in a capacitor–resistor discharge circuit will:** A) decrease the time constant **B) increase the time constant** C) not affect the time constant D) make the discharge instantaneous	**Correct Answer:** (B) increase the time constant *Topic: Capacitor Discharge*
Q35	**A capacitor of capacitance C is fully charged to voltage V. If V is doubled, the energy stored becomes:** A) double **B) four times** C) half D) unchanged	**Correct Answer:** (B) four times *Topic: Energy in Capacitor*
Q36	**A parallel plate capacitor has plate area A and separation d. Capacitance is proportional to:** A) d/A **B) A/d** C) $A \cdot d$ D) $1/(A \cdot d)$	**Correct Answer:** (B) A/d *Topic: Capacitance*

Q37	**Two like point charges are brought closer. Their electric potential energy:** A) decreases B) remains the same **C) increases** D) becomes zero	**Correct Answer:** (C) increases *Topic: Potential Energy*
Q38	**Action potentials in the body are used to:** A) produce hormones **B) initiate movements, thoughts and behaviours** C) create new cells D) digest food	**Correct Answer:** (B) initiate movements, thoughts and behaviours *Topic: Bioelectricity*
Q39	**Which of the following is NOT a typical use of a capacitor?** A) Flash guns B) Smoothing DC supply **C) Amplifying DC voltage** D) Timing circuits	**Correct Answer:** (C) Amplifying DC voltage *Topic: Uses of Capacitors*
Q40	**Electric potential is a:** A) vector quantity **B) scalar quantity** C) dimensionless quantity D) tensor quantity	**Correct Answer:** (B) scalar quantity *Topic: Electric Potential*

Section B: Short Questions with Answers (20 Questions)

Answer each question concisely as required in FBISE exams.

SQ1	**Define electric potential at a point. Give its SI unit.** *Topic: Electric Potential*	**Answer:** Electric potential at a point is the work done per unit positive charge in bringing a small test charge from infinity to that point. Its SI unit is the volt (V), where 1 V = 1 J/C.
SQ2	**State the relationship between electric field and electric potential gradient.** *Topic: Electric Field & Potential*	**Answer:** The electric field at a point is equal to the negative of the potential gradient at that point: E = -dV/dr. This means the field points in the direction of decreasing potential.
SQ3	**Write the formula for electric potential energy of two point charges and explain each term.** *Topic: Potential Energy*	**Answer:** $E_p = Qq/(4\pi\varepsilon_0 r)$, where Q and q are the two point charges, r is the distance between them, and ε_0 is the permittivity of free space (8.85×10^{-12} F/m).
SQ4	**Define capacitance and state its SI unit.** *Topic: Capacitance*	**Answer:** Capacitance is the charge stored per unit potential difference: C = Q/V. Its SI unit is the farad (F), where 1 F = 1 C/V. It measures the ability of a conductor to store charge.
SQ5	**Derive the formula for the combined capacitance of two capacitors connected in series.** *Topic: Capacitors in Series*	**Answer:** For capacitors in series, the voltage adds: $V = V_1 + V_2 \rightarrow Q/C = Q/C_1 + Q/C_2$. Dividing by Q: $1/C = 1/C_1 + 1/C_2$. The combined capacitance is less than the smallest individual value.
SQ6	**Derive the formula for combined capacitance of capacitors in parallel.** *Topic: Capacitors in Parallel*	**Answer:** In parallel, the same voltage V appears across each capacitor. Total charge $Q = Q_1 + Q_2 = C_1V + C_2V = (C_1 + C_2)V$. Therefore $C = C_1 + C_2$. Combined capacitance is the sum.
SQ7	**Show that the energy stored in a capacitor is U = ½QV = ½CV² = Q²/2C.** *Topic: Energy in Capacitor*	**Answer:** Work done to charge a capacitor equals the area under the V-Q graph. Since V = Q/C is linear, the area = ½QV. Substituting V = Q/C gives $U = Q^2/2C$, and substituting Q = CV gives $U = ½CV^2$.
SQ8	**How can the energy stored in a capacitor be found from a potential-charge graph?** *Topic: Energy from Graph*	**Answer:** The energy is equal to the area under the potential-charge (V vs Q) graph. Since V is proportional to Q (V = Q/C), the graph is a

		straight line through the origin, and the area = ½QV = ½CV².
SQ9	**Write the equation for the decay of charge on a discharging capacitor and define the time constant.** *Topic: Capacitor Discharge*	**Answer:** $Q = Q_0 \exp(-t/RC)$, where Q_0 is the initial charge and RC is the time constant τ. The time constant τ = RC is the time taken for the charge to fall to 1/e (≈37%) of its initial value.
SQ10	**Describe how the voltage and current vary with time when a capacitor discharges through a resistor.** *Topic: Capacitor Discharge*	**Answer:** Both voltage and current decay exponentially: $V = V_0e^{(-t/RC)}$ and $I = I_0e^{(-t/RC)}$. They decrease rapidly at first and then more slowly, asymptotically approaching zero.
SQ11	**What effect does increasing resistance have on the discharge of a capacitor?** *Topic: Capacitor Discharge*	**Answer:** Increasing resistance increases the time constant τ = RC. The capacitor discharges more slowly - charge, voltage, and current all take longer to decay, and the discharge curve becomes less steep.
SQ12	**List any three uses of capacitors in household appliances with a brief reason for each.** *Topic: Uses of Capacitors*	**Answer:** 1) Flash guns: release large energy quickly. 2) Electric fans/refrigerators: capacitors start the motor by providing phase-shifted current. 3) Rectification circuits: smooth out pulsating DC by charging/discharging rapidly.
SQ13	**What are ion channels? What is their role in generating action potentials?** *Topic: Bioelectricity*	**Answer:** Ion channels are proteins on the cell surface that open to allow specific ions to pass through the membrane. When a cell is stimulated, positive ions enter, making the inside positive and triggering electrical pulses called action potentials.
SQ14	**Explain briefly how bioelectricity is generated in animals.** *Topic: Bioelectricity*	**Answer:** Stimulation opens ion channels allowing positive charges into the cell. The interior becomes positively charged, triggering further electrical currents which generate action potentials. These signals control movement, thoughts, and behaviour.
SQ15	**What is Electrophorus Electricus and how does it generate electric shocks?** *Topic: Bioelectricity*	**Answer:** Electrophorus Electricus (electric eel) is an aquatic species that generates external electric shocks through internal biological mechanisms that function as batteries, converting chemical energy directly into electrical energy.
SQ16	**Define electroreception.** *Topic: Bioelectricity*	**Answer:** Electroreception is the ability of certain animals to detect weak, naturally occurring electrostatic

		fields in the environment. It helps them navigate, locate prey, and communicate.
SQ17	**On what factors does the capacitance of a parallel plate capacitor depend?** *Topic: Capacitance*	**Answer:** $C = \varepsilon_0 A/d$ depends on: (1) plate area A - larger area gives more capacitance; (2) separation d - smaller separation gives more capacitance; (3) the dielectric material between the plates.
SQ18	**Two point charges +Q and -Q are placed apart. Where is the electric potential zero?** *Topic: Electric Potential*	**Answer:** For equal and opposite charges, the potential is zero at the midpoint between the charges (and along the perpendicular bisector plane), because the positive and negative contributions cancel exactly at those points.
SQ19	**Sketch and explain the shape of a charge-time graph for a discharging capacitor.** *Topic: Capacitor Discharge*	**Answer:** The graph is an exponential decay curve starting at Q_0 (initial charge) and falling towards zero. It is steep initially (high current) and gradually less steep over time. This arises because the discharge rate is proportional to the remaining charge.
SQ20	**A capacitor of 500 μF is charged to 12 V. Calculate the energy stored.** *Topic: Energy in Capacitor*	**Answer:** $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 500 \times 10^{-6} \times 12^2 = \frac{1}{2} \times 500 \times 10^{-6} \times 144 = 0.036$ J = 36 mJ.