Mark Scheme – Semiconductors

Q	Expanded Answer Guidance	Marks
1	Semiconductor: • Material with conductivity between conductor and insulator • Conductivity can be controlled • Examples: silicon, germanium Accept: • Intermediate conductor definition	1
2a	Metal: • No/very small band gap • Bands overlap Insulator: • Large band gap • Poor conductivity Semiconductor: • Small band gap • Conductivity possible with energy	3
2b	Diagram should show: • Valence band • Conduction band • Small gap between Accept: • Clearly labelled sketch	1
2c	Measured in: • Electron volts (eV) Accept: • eV abbreviation	1
2d	Heating: • Increases electron energy • More electrons cross band gap • Conductivity increases Accept: • Resistance decreases	2

3a	Doping: • Adding impurity atoms • Changes conductivity • Creates charge carriers	2
3b	P-type: • Trivalent doping • Creates holes N-type: • Pentavalent doping • Creates electrons Accept: • Majority carrier comparison	4
4a	Formation of PN Junction: • P-type joined to N-type • In middle both mix as electrons cancel holes • Depletion region forms • No free charge carriers in region • Blocks current flow in one direction	6
4b	Reverse bias: • Blocks current flow • Until breakdown voltage reached • Which permanently damages diode	3
5a	Diode use: • One-way current flow • Rectification • Protection • Signal routing	1
5b	Junction diode: • Standard one-way conduction Zener diode: • Reverse breakdown at fixed voltage • Voltage regulation	2
6a	Transistor role: • Switching • Amplification • Signal control	2

6b	BJT: • Current controlled • Base current needed FET: • Voltage controlled • High input impedance	4