

Name: _____

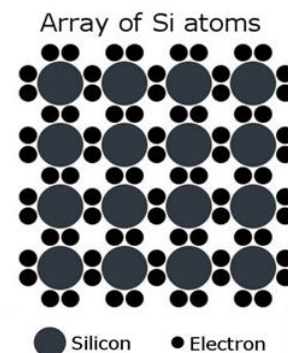
Student No: _____

1. Considering the following solid materials, write down their relevant solid forms: single-crystal, poly-crystalline, or amorphous. (30 marks)

- a) Si ingot: single-crystal
- b) Metallurgical Grade Si (MGS): poly-crystalline
- c) Sand: amorphous
- d) Diamond in a ring: single-crystal
- e) Gate SiO₂ in a MOSFET: amorphous

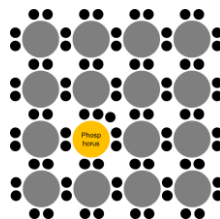
2. This is an array of Si atoms. (36 marks)

- a) What is an N-type semiconductor?
What kind of element is it doped with?
Please also draw the array of doped-Si atoms.
- b) What is a P-type semiconductor?
What kind of element is it doped with?
Please also draw the array of doped-Si atoms.



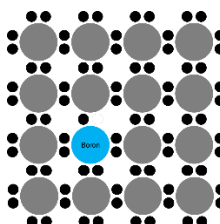
(a) An n-type semiconductor is a type of semiconductor where electrons serve as the majority charge carriers, leading to a negative charge transport characteristic.

Doped with V group: N, P, As



(b) A p-type semiconductor is an intrinsic semiconductor doped with boron or indium. The majority of carriers in p-type semiconductors are holes.

Doped with III group: B, Al, Ga



3. The pressure in a clean room is b pressure. (4 points)

- a. Negative b. Positive

4. Please define the energy of a photon by its wavelength. (9 point)

The energy of a photon $E = hf = \frac{hc}{\lambda}$

where h is Planck's constant, c is the speed of light in a vacuum, and λ is the wavelength of the photon.

5. Consider the photomask pattern shown below, where the dark region blocks light and white region is transparent, (21 marks)

- a) Draw the photoresist pattern after development for a negative-tone resist.
b) Repeat (a) for a positive-tone resist, but is over-exposed.
c) Repeat (a) for a positive-tone resist, but shows proximity effect.

