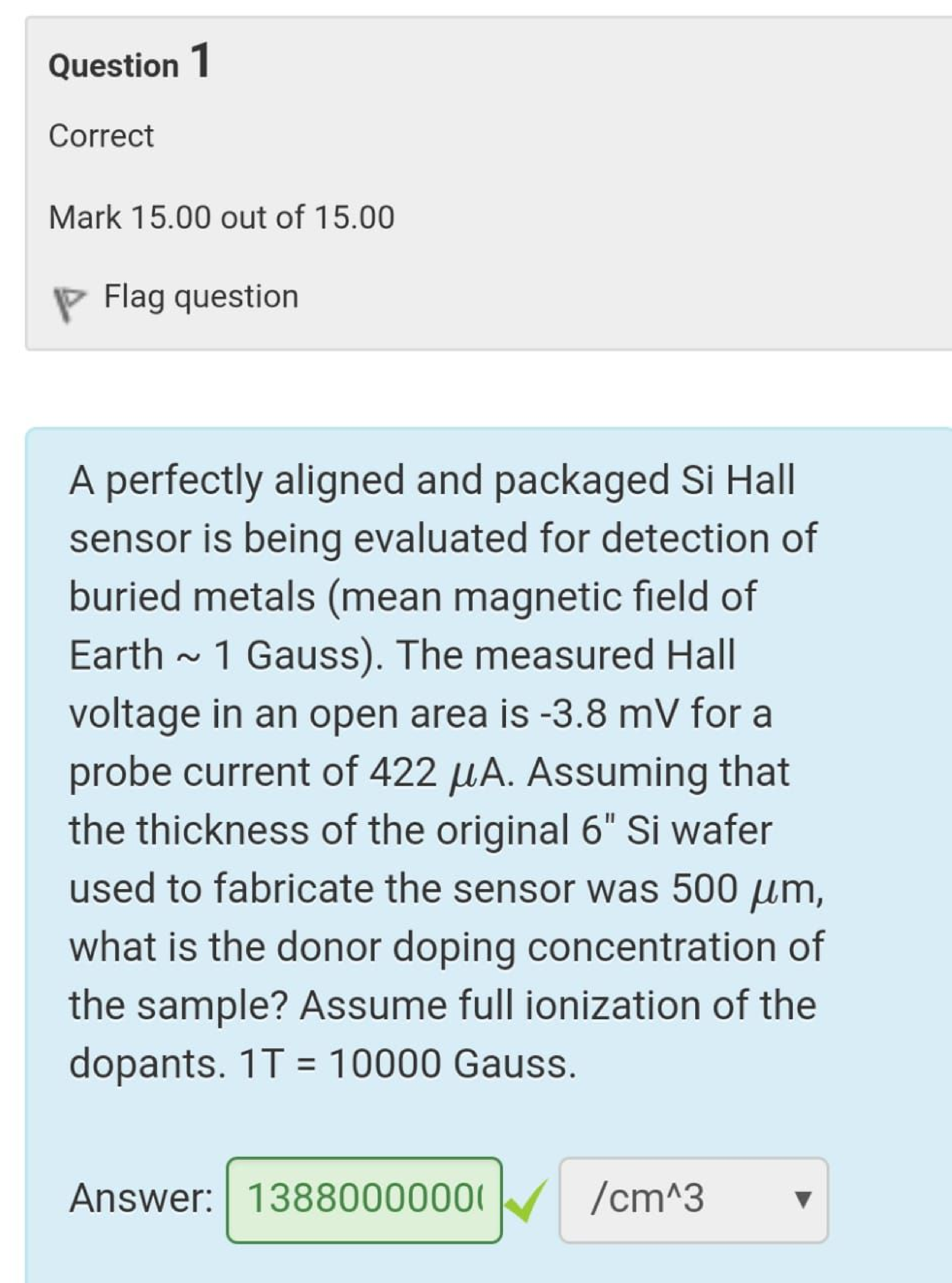


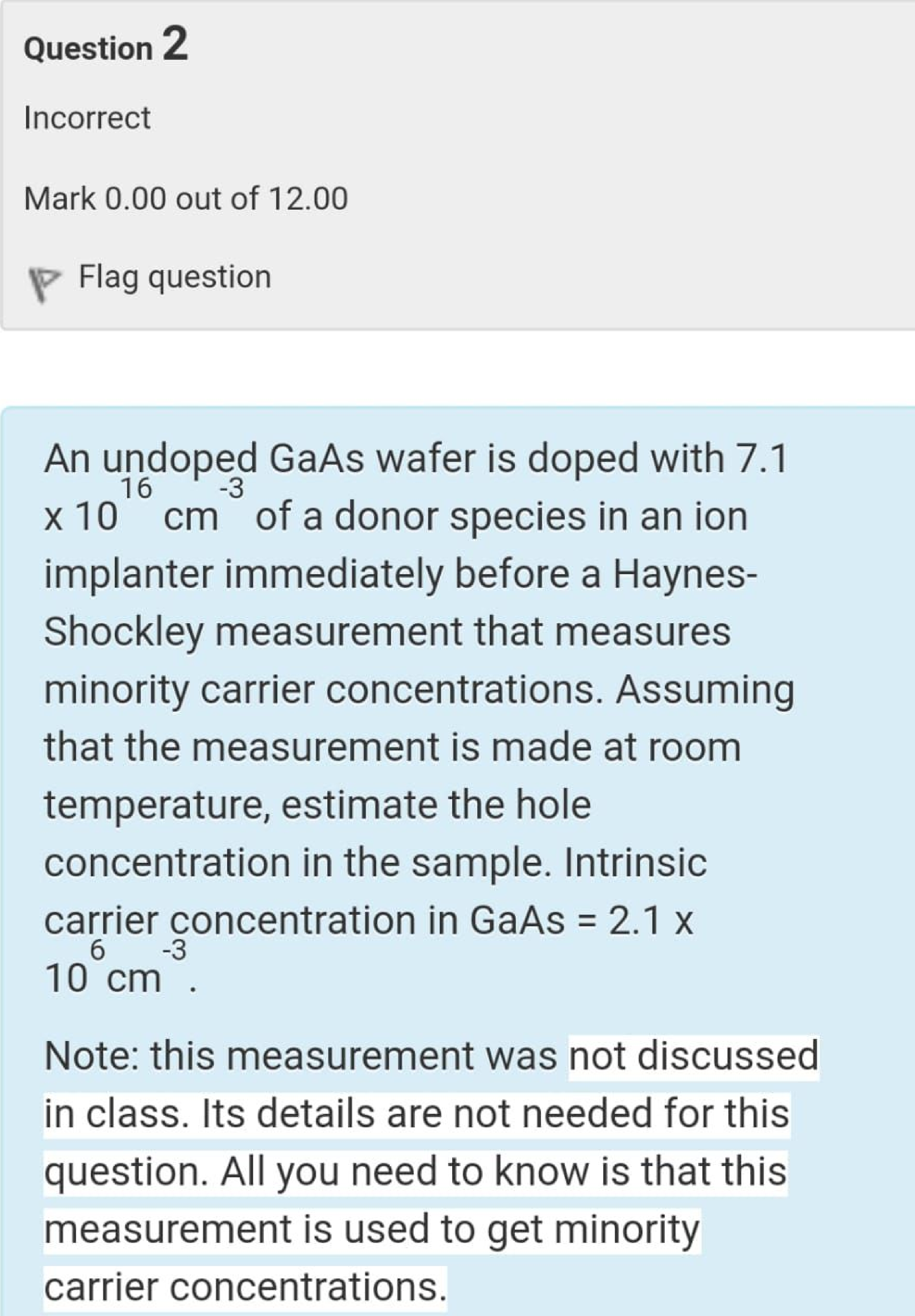
Question 1

Correct

Mark 15.00 out of 15.00

A perfectly aligned and packaged Si Hall sensor is being evaluated for detection of buried metals (mean magnetic field of Earth ~ 1 Gauss). The measured Hall voltage in an open area is -3.8 mV for a probe current of 422 μA. Assuming that the thickness of the original 6" Si wafer used to fabricate the sensor was 500 μm, what is the donor doping concentration of the sample? Assume full ionization of the dopants. 1T = 10000 Gauss.

Answer: 138800000 ✓ /cm^3 ▼



Question 2

Incorrect

Mark 0.00 out of 12.00

Flag question

An undoped GaAs wafer is doped with 7.1 x 10^{16} cm^{-3} of a donor species in an ion implanter immediately before a Haynes-Shockley measurement that measures minority carrier concentrations. Assuming that the measurement is made at room temperature, estimate the hole concentration in the sample. Intrinsic carrier concentration in GaAs = 2.1 x 10^{6} cm^{-3}.

Note: this measurement was not discussed in class. Its details are not needed for this question. All you need to know is that this measurement is used to get minority carrier concentrations.

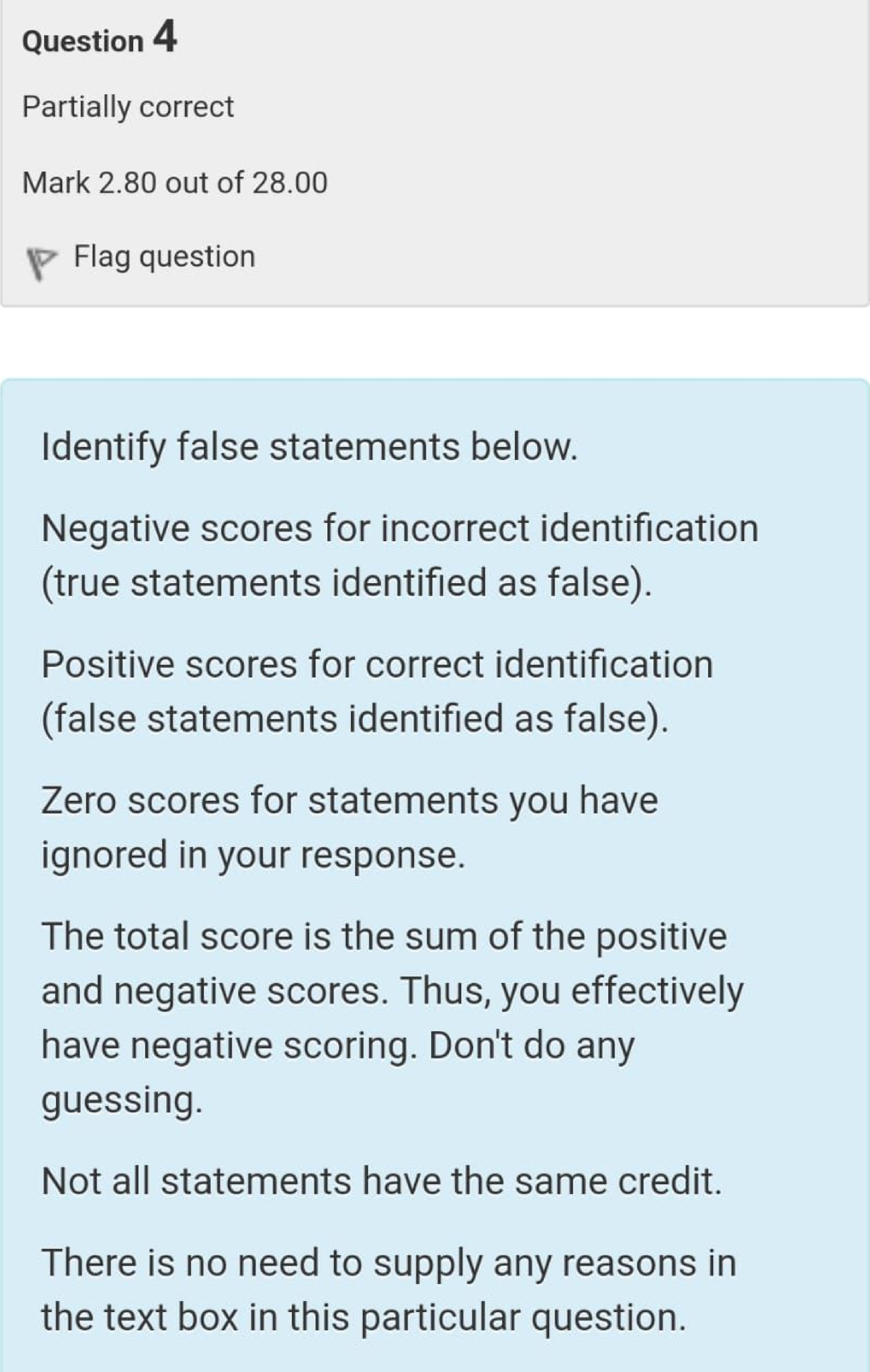
Question 3

Not answered

Marked out of 15.00

Flag question

An n-channel GaN FET with a channel length of L=8.2 μm and a low-field electron mobility of 1031 cm^2/(V.s) is being evaluated for a high power application where it will be subjected to high drain bias, V_D. As a designer, if you assume a linear relationship for velocity to the channel electric field (=$\frac{V_D}{L}$) and ignore the effect of the gate or the insulator, what is the maximum drain bias that you can analyze it at before picking up a maximum error of 9.7% in the velocity estimate with respect to the model discussed in class that explicitly takes velocity saturation into account? Assume that the factor β=2 for electrons, and v_{sat}=2.5 x 10^7 cm/s.



Question 4

Partially correct

Mark 2.80 out of 28.00

Flag question

Identify false statements below.

Negative scores for incorrect identification (true statements identified as false).

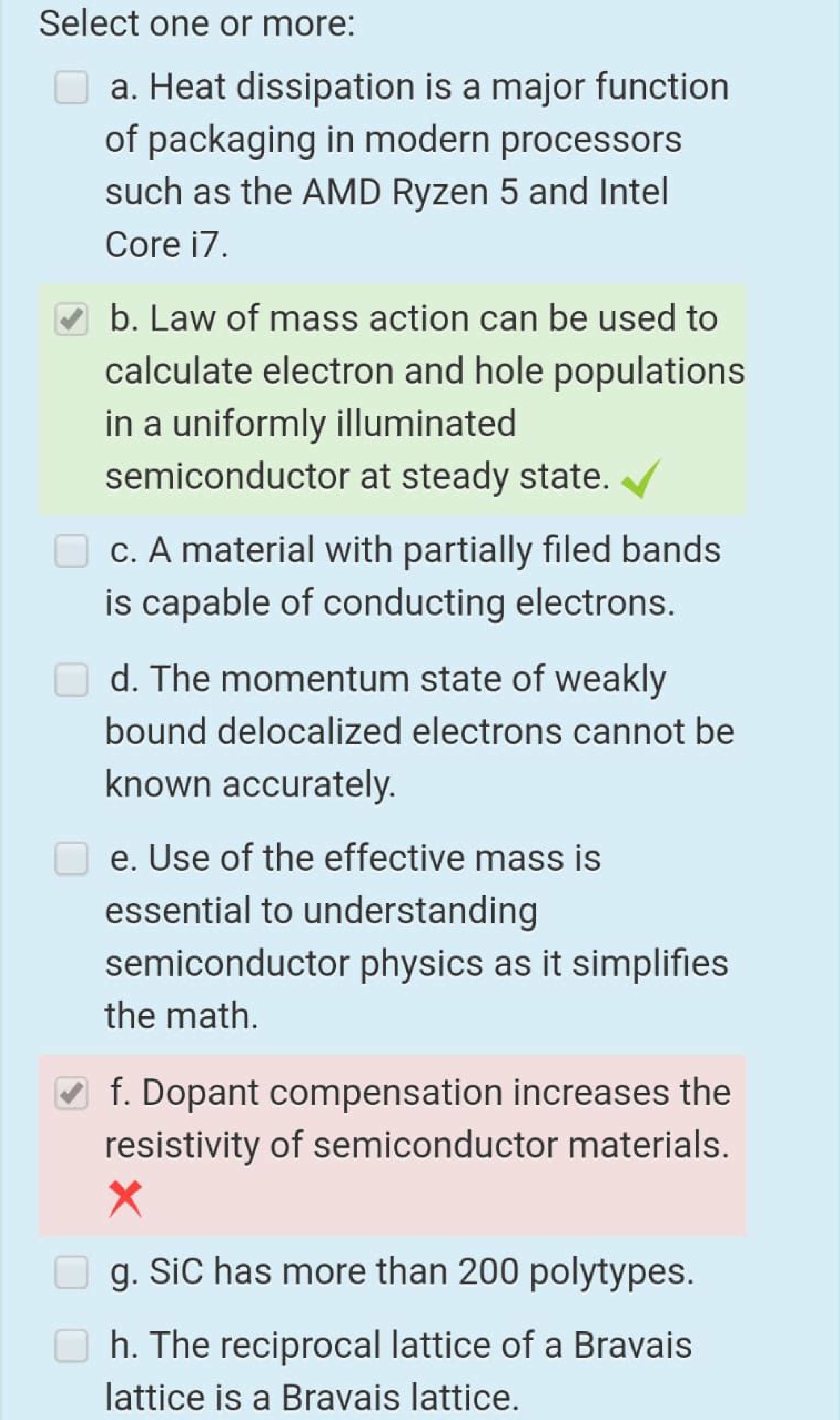
Positive scores for correct identification (false statements identified as false).

Zero scores for statements you have ignored in your response.

The total score is the sum of the positive and negative scores. Thus, you effectively have negative scoring. Don't do any guessing.

Not all statements have the same credit.

There is no need to supply any reasons in the text box in this particular question.



Select one or more:

☐ a. Heat dissipation is a major function of packaging in modern processors such as the AMD Ryzen 5 and Intel Core i7.

☑ b. Law of mass action can be used to calculate electron and hole populations in a uniformly illuminated semiconductor at steady state. ✓

☐ c. A material with partially filed bands is capable of conducting electrons.

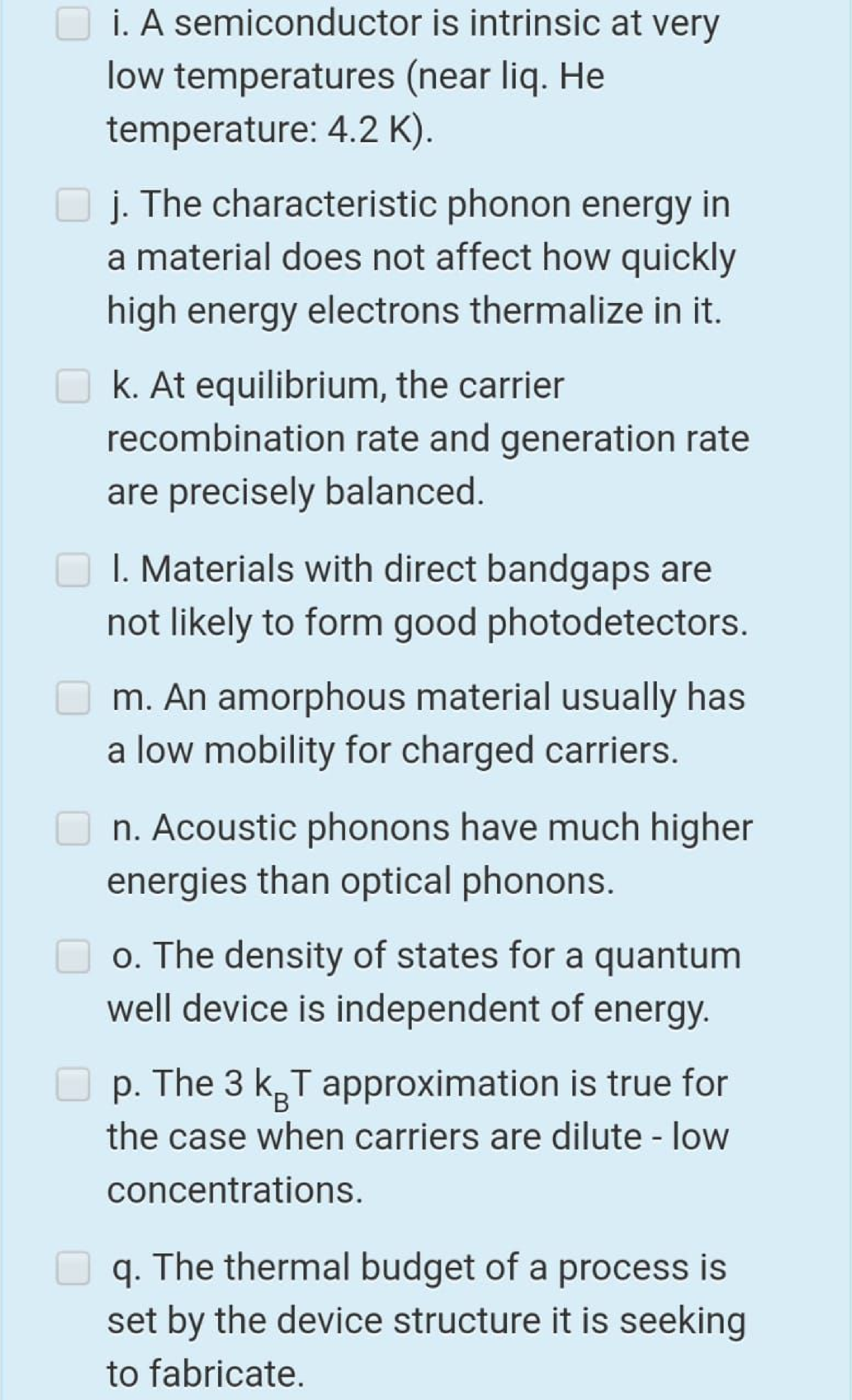
☐ d. The momentum state of weakly bound delocalized electrons cannot be known accurately.

☐ e. Use of the effective mass is essential to understanding semiconductor physics as it simplifies the math.

☑ f. Dopant compensation increases the resistivity of semiconductor materials. ✗

☐ g. SiC has more than 200 polytypes.

☐ h. The reciprocal lattice of a Bravais lattice is a Bravais lattice.



☐ i. A semiconductor is intrinsic at very low temperatures (near liq. He temperature: 4.2 K).

☐ j. The characteristic phonon energy in a material does not affect how quickly high energy electrons thermalize in it.

☐ k. At equilibrium, the carrier recombination rate and generation rate are precisely balanced.

☐ l. Materials with direct bandgaps are not likely to form good photodetectors.

☐ m. An amorphous material usually has a low mobility for charged carriers.

☐ n. Acoustic phonons have much higher energies than optical phonons.

☐ o. The density of states for a quantum well device is independent of energy.

☐ p. The 3 k_BT approximation is true for the case when carriers are dilute - low concentrations.

☐ q. The thermal budget of a process is set by the device structure it is seeking to fabricate.

☐ r. The intrinsic carrier energy level is located slightly below mid gap for Si.

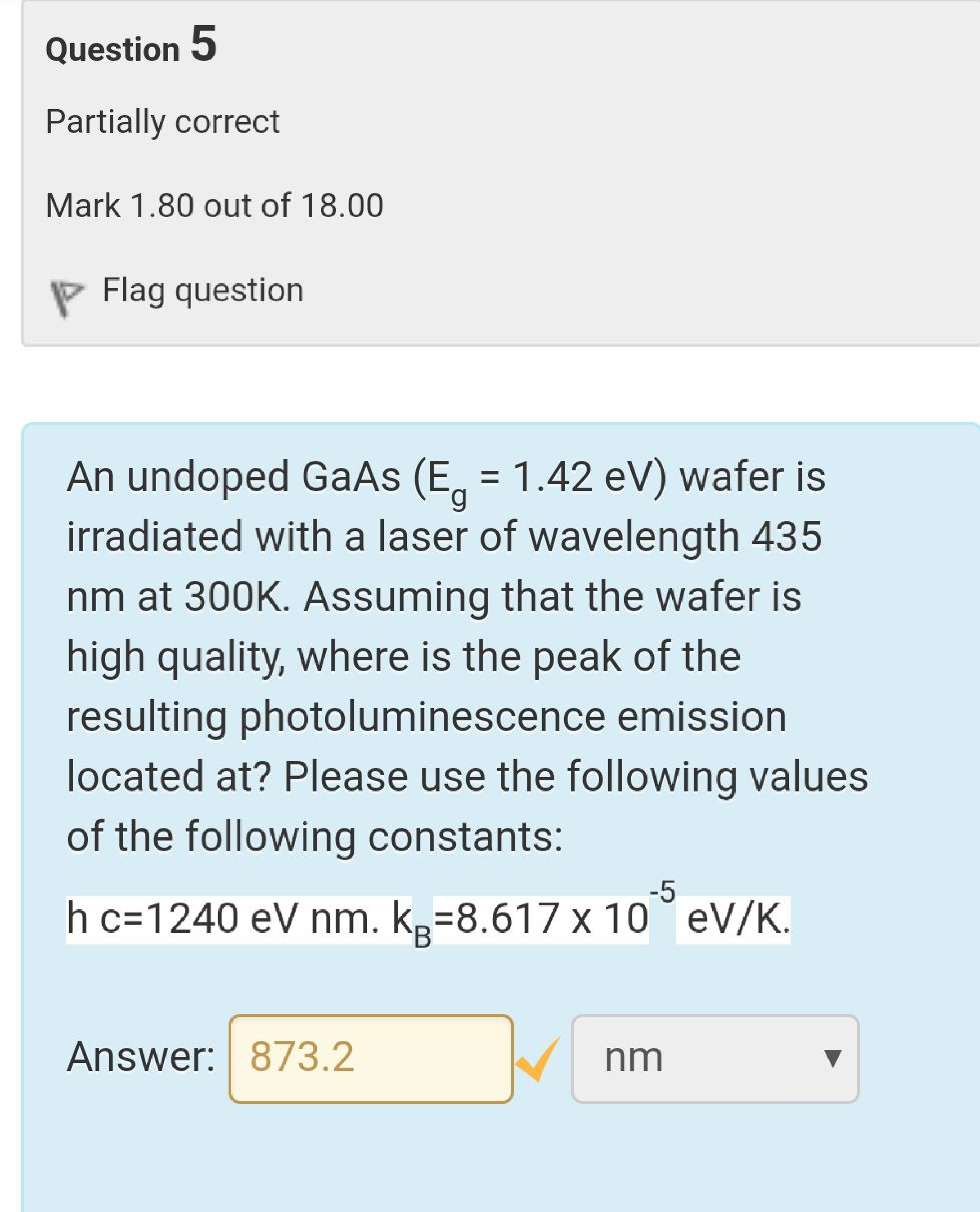
☐ s. Bands in real space tilt under application of bias because it changes the relative energies of electrons at different spatial points.

☐ t. X-ray diffraction measurements can be used to extract interplanar spacings of polycrystalline materials.

Give your reasons

Your answer is partially correct.

You have correctly selected 1.
The correct answer is: The characteristic phonon energy in a material does not affect how quickly high energy electrons thermalize in it., A semiconductor is intrinsic at very low temperatures (near liq. He temperature: 4.2 K)., Law of mass action can be used to calculate electron and hole populations in a uniformly illuminated semiconductor at steady state.,



Question 5

Partially correct

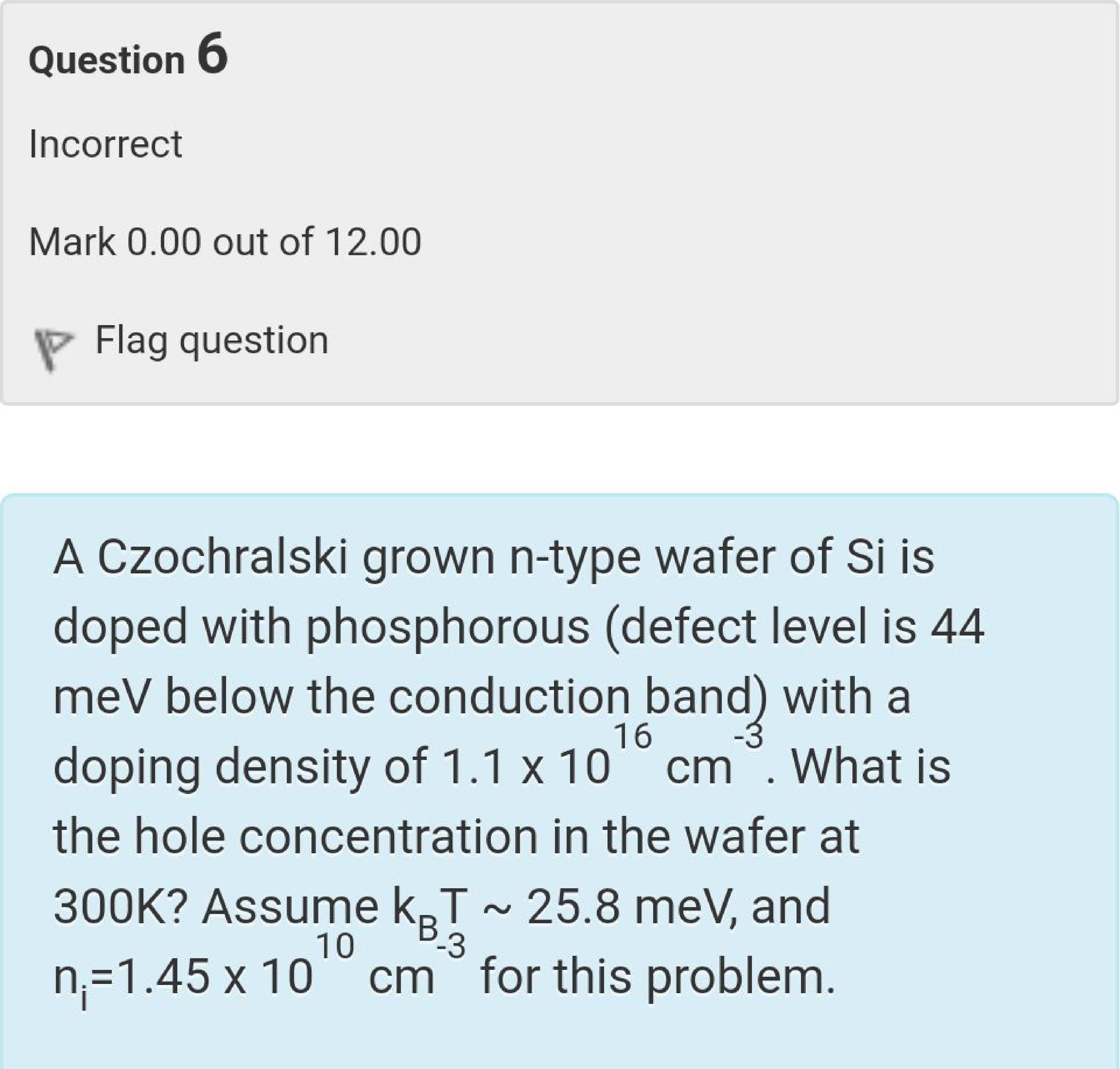
Mark 1.80 out of 18.00

Flag question

An undoped GaAs (E_g = 1.42 eV) wafer is irradiated with a laser of wavelength 435 nm at 300K. Assuming that the wafer is high quality, where is the peak of the resulting photoluminescence emission located at? Please use the following values of the following constants:

h c=1240 eV nm. k_B=8.617 x 10^{-5} eV/K.

Answer: 873.2 ✓ nm ▼



Question 6

Incorrect

Mark 0.00 out of 12.00

Flag question

A Czochralski grown n-type wafer of Si is doped with phosphorous (defect level is 44 meV below the conduction band) with a doping density of 1.1×10^{16} cm^{-3}. What is the hole concentration in the wafer at 300K? Assume $k_B T \sim 25.8$ meV, and $n_i = 1.45 \times 10^{10}$ cm^{-3} for this problem.