

Theoretical Exam



APhO

Asian Physics Olympiad
Dhahran - Saudi Arabia 2025

A2-1

Singapore English (Singapore)

Waves and Phase Transitions in Spin Systems (10.0 points)

Part A. Spin precession and interactions (1.2 points)

A.1 (0.3 pt)

$$\gamma =$$

A.2 (0.4 pt)

$$\omega_L =$$

A.3 (0.5 pt)

$$J_0 =$$

Part B. Spin Waves (4.5 points)

B.1 (0.3 pt)

$$\vec{B}_{i,\text{eff}} =$$

B.2 (0.3 pt)

$$\frac{d\vec{S}_i}{dt} =$$

B.3 (2.0 pt)

$$\omega(k) =$$

B.4 (0.6 pt)

$$m_{\text{eff}} =$$

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A2-2

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B.5 (1.3 pt)

$$m_{\text{eff}} =$$

Part C. Phase transitions in spin chains (4.3 points)

C.1 (0.5 pt)

$$\frac{p_{\uparrow}}{p_{\downarrow}} =$$

DELEGATION PRINT

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A2-3

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C.2 (1.0 pt)

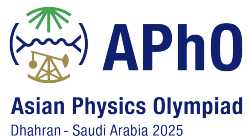
$\bar{s} =$

Sketch for $h_o \gg k_B T$:

Sketch for $h_o \approx k_B T$:

Sketch for $h_o \ll k_B T$:

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A2-4

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C.3 (0.2 pt)

$$E_g =$$

C.4 (0.2 pt)

$$\tilde{J}_{\text{eff}} =$$

C.5 (1.2 pt)

Equation for $\bar{s}$:

$$T_c =$$

C.6 (1.0 pt)

When $T < T_c$ and $T_c - T \ll T_c$, the possible values of $\bar{s}$ are:

sketch of $\bar{s}$ as a function of T :

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A2-5

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C.7 (0.2 pt)

Circle the right answer:

$T > T_c$: paramagnetic ferromagnetic

$T < T_c$: paramagnetic ferromagnetic

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