**Total Number of Pages in Section A (including top page):** 7

EXAMINATION SCRIPT

| STUDENT NO. | | | | | | |
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| DEPARTMENT: | MME (L-2, T-1) |
|---|---|
| BANGLADESH UNIVERISTY OF ENGINEERING AND TECHNOLOGY | |

| COURSE NO. | MME 231 | DATE | 25 September, 2021 |
|---|---|---|---|
| COURSE TITLE | Materials Thermodynamics | | |

# SECTION A

**Declaration on the Online Course Conduct by Undergraduate Student of BUET for COVID-19 Situation**

Please write the declaration as per no. 2 of "Instructions" given in the footer below in your own handwriting and sign it.

On my honour, I bearing Student No. 1711018 hereby declare that,

I shall not misuse, in any form or method, the course materials including Lecture notes, Reading materials, Audio and video records of the lectures of this course. I shall not adopt any unfair means during final examination and shall not receive any help or offer/provide help to anyone. I shall preserve hard copy and soft copies of the answer scripts and will not expose the same to any person/party/media. I agree to accept any punitive measure taken by BUET authority if at any time during or after the completion of the course it is revealed/violated otherwise.

**Signature** Amin **Date** 25 September, 2021

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5. After completing the exam, **before scanning**, please write the total number of pages in this Section (including the top page) on the top right corner of the top page.

## Section-A

### Ans. to Ques. no. 4

(a)

**Concept of wettability :**

Wettability is defined as the measurement of liquid's ability of interraction with other fluids and/or solid surface. Wettability ~~is~~ measures the level of wetting when solid or liquid phase interact with each other. It measures the surface attribute of polymer and performs many necessary tasks in printing and coating of liquids. Wettability is measured by contact angle.

Lower contact angle ($\leq 90^\circ$) refers to greater wettability and larger/higher contact angle ($\geq 90^\circ$) refers to lower wettability.

**To remove 'hot shortness' defect in steel:**

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## Ans to Q.2

here,

$$\langle C \rangle + \frac{1}{2}(O_2) = (CO) \; ; \; \Delta f_i = -26700 - 21.0\,T \text{ cal} \quad \text{(I)}$$

$$\langle C \rangle + (O_2) = (CO_2) \; ; \; \Delta f_i = -94200 - 0.2\,T \text{ cal} \quad \text{(II)}$$

$$\langle H_2 \rangle + \frac{1}{2}(O_2) = (H_2O) \; ; \; \Delta f_i = -58900 + 13.8\,T \text{ cal} \quad \text{(III)}$$

the reaction will be,

(II) − (I) − (III) ⇒

$$\langle C \rangle + (O_2) - \langle C \rangle - \frac{1}{2}O_2 - (H_2) - \frac{1}{2}(O_2) = (CO_2) - (CO) - H_2O$$

$$(H_2) = (CO_2) - (CO) - (H_2O)$$

$$\therefore (CO) + (H_2O) = (CO_2) + (H_2)$$

$$\Delta f_i = -94200 - 0.2T + 26700 - 21.0T + 58900 + 13.0T$$

$$= (-8600 + 7.8T) \text{ cal}$$

At 1200K,

$$\Delta G^\circ = (-3600 + 7.8 \times 1200K)\ cal$$

$$= 760\ cal$$

$\Delta G^\circ$ for the main reaction is $= -760$ cal.

we know,

$$\Delta G^\circ = -RT \ln K$$

$$\therefore \ln K = -\frac{\Delta G^\circ}{RT}$$

$$K = e^{-\frac{\Delta G^\circ}{RT}} = e^{-\frac{760}{1.987\ Kcal \times 1200K}}$$

$$\therefore K = 1.3754$$

$$(CO_2) + (H_2) \rightarrow (CO) + (H_2O)$$

total mole at equilibriam $= 1-a+1-a+3$ moles

$$= 0.5$$

Now,

$$K = \frac{P_{CO_2} \cdot P_{H_2O}}{P_{H_2} \cdot P_{CO_2}}$$

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## 1 (b)

Here,

$$\log P(\text{bar}) = 8.89 - \frac{1400}{T} - 0.86 \log T$$

$$2.303 \log p(\text{bar}) = 20.335 - \frac{33163.2}{T} - 0.85 \ln T$$

$$\Rightarrow \partial \ln P(\text{bar}) = \left(-\frac{3.3163}{T^2} - \frac{0.85}{T}\right) dT$$

$$= \left(\frac{3.3163}{T^2}\right) dT = \frac{\Delta H^G}{RT^2} dT$$

$$\therefore \frac{\Delta H^G}{RT^2} = \frac{33163.2 - 0.85T}{T^2}$$

$$\therefore \Delta H^G = (33163.2 - 0.85 \times T) \times R$$

at 2350 K,

$$\Delta H^G = (33163.2 - 0.85 \times 2350K) \times 8.3147 \frac{}{\text{mol-K}}$$

$$= 259111.628 \text{ J/mol.}$$

Now,
we get,

$$K = \frac{a^2 + 0.3a}{a^2 - 0.2a + 0.01} = 1.3754$$

$$\Rightarrow \quad a = 1.507$$

At equilibriam,

$$x_{CO} = \frac{.3 + a}{0.5} = 3.614$$

$$x_{H_2O} = \frac{a}{0.5} = 3.014$$

$$x_{H_2} = \frac{.1 - a}{0.5}$$

Now,

$$Q = \frac{P_{NH_3}^2}{P_{H_2}^3 \times P_{H_2}}$$

$$= 6.428 \times 10^{-7} \text{ atm}^{-2}$$

$\therefore Q/K < 1$, it will proced to equilibriam

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$\Delta G = RT \ln \frac{Q}{K}$ (by putting values)

$= -85143.9024$ J/mol (Ans)

25911.6298 J/mol heat is required at 2350K.

$\Delta H_G = 129555.81$ J (Ans)

## 4(b)

$\Delta G^\circ = RT \ln K$ (putting values)

$\therefore K = e^{-\frac{\Delta G^\circ}{RT}}$

$= 539504.03$

$N_2 + 3H_2 \rightarrow 2NH_3$.

$T = 100^\circ C = 373K$