Unit 14 - Week 12

Assignment 12

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-10-26, 23:59 IST.

1) Gears in automobiles require a combination of wear resistance and toughness. This is achieved using case carburized plain carbon steel gears. The gear is heat treated in carbon atmosphere. It is found that the initial concentration of the gear is $0.2\%\ C$ and the concentration on the surface is $1.5\%\ C$. How much time (in hrs) is it required to get a concentration of $0.4\%\ C$ at a depth of $2mm$? Assume the gear to be semi-infinite and the diffusion co-efficient of C in plain carbon steel is $1.6 \times 10^{-11} m^2/s$ at the temperature of interest

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 16.9,17.1

1 point

2) Determine the correctness of the statement or otherwise. *1 point*
Assertion (A): During case carburization of steel, the composition profile takes the form of complementary error function.
Reason(R): The concentration of carbon at the surface and at the inner region are fixed

- Both A and R are true but R is NOT the correct explanation of A
- Both A and R are true and R is the correct explanation of A
- A is false but R is true
- Both A and R are false

No, the answer is incorrect.
Score: 0
Accepted Answers:
Both A and R are true and R is the correct explanation of A

3) A thin film of copper is coated on nickel plate. The plate is heat treated at 700^oC and the below figure represents the ln C vs x^2 curve where C is the composition and x is the distance into Ni plate from the Cu-Ni interface. What does the slope of the line in the given plot represents? Where, Q-Activation Energy; R-Gas Constant; k-Boltzmann's Constant; D-Diffusivity; t-Time; T-Temperature; *1 point*

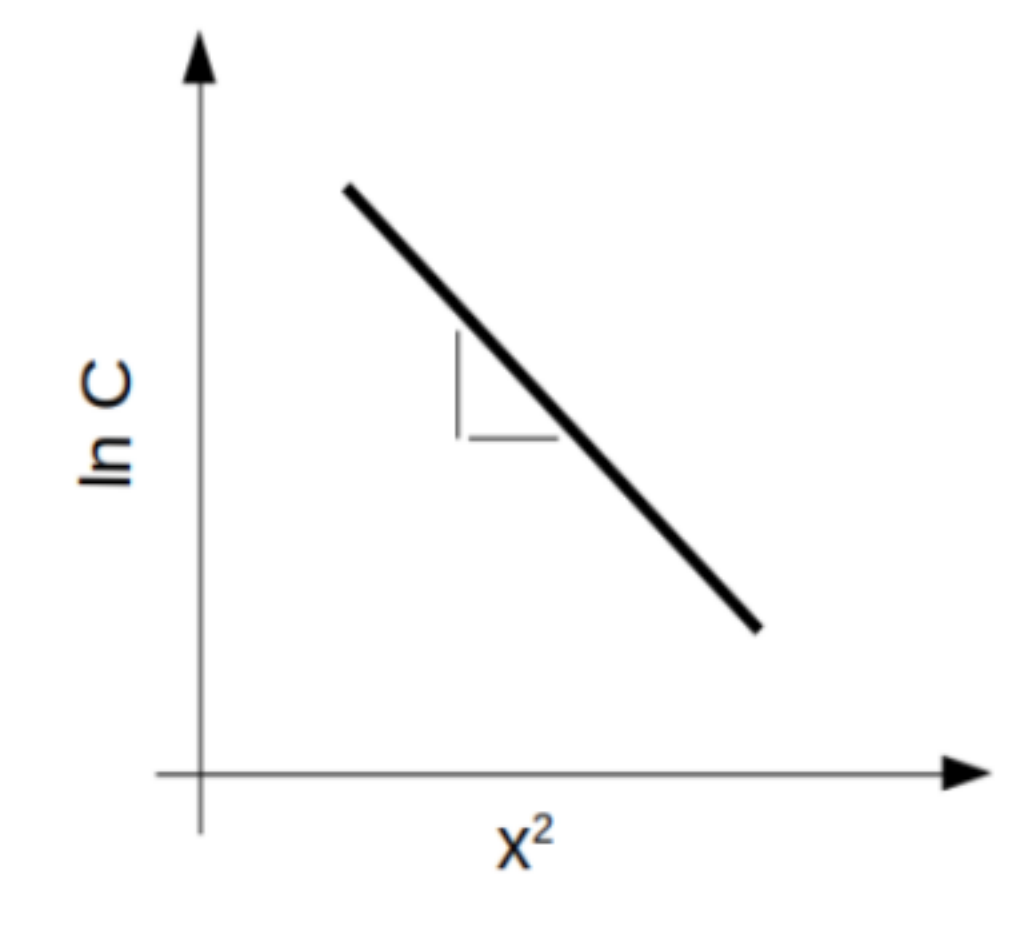

Figure 1: ln C vs x²

- $-Q/RT$
- $-Q/kT$
- $\frac{1}{2\sqrt{Dt}}$
- $\frac{-1}{4Dt}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{-1}{4Dt}$

4) A typical as-cast alloy has segregation (in inter-dendritic region) and homogenization heat treatment is generally done to eliminate the segregation. The type of mould used for casting will affect dendritic arm-spacing.A hypothetical alloy, cast in steel mould has a dendritic arm length of L and it took T hrs to homogenize the alloy at 700^oC. If the same alloy is cast in sand mould and has a dendritic arm-spacing of 3L, how much will it take to homogenize the alloy at same extent as the previous case at 700^oC? *1 point*

- T /3
- 3T
- 4.9T
- 9T

No, the answer is incorrect.
Score: 0
Accepted Answers:
9T

5) For very large values of x, the function $erf(x)$ can be approximated as ? *1 point*

- $\frac{2}{\sqrt{\pi}} \frac{3x}{3+x^2}$
- $\frac{-e^{-x^2}}{6} + \frac{-e^{-\frac{4}{3}x^2}}{2}$
- $1 + \frac{-e^{-x^2}}{6} - \frac{e^{-\frac{4}{3}x^2}}{2}$
- None of the above

No, the answer is incorrect.
Score: 0
Accepted Answers:
$1 + \frac{-e^{-x^2}}{6} - \frac{e^{-\frac{4}{3}x^2}}{2}$

6) Chrome plating is done on carbon steels to improve their corrosion resistance. At high temperatures, Cr starts diffusing into the steel. Which of the two plots can possibly represent the evolution of composition profile with time at the same temperature? In all the figures, assume t1 < t2 < t3 *1 point*

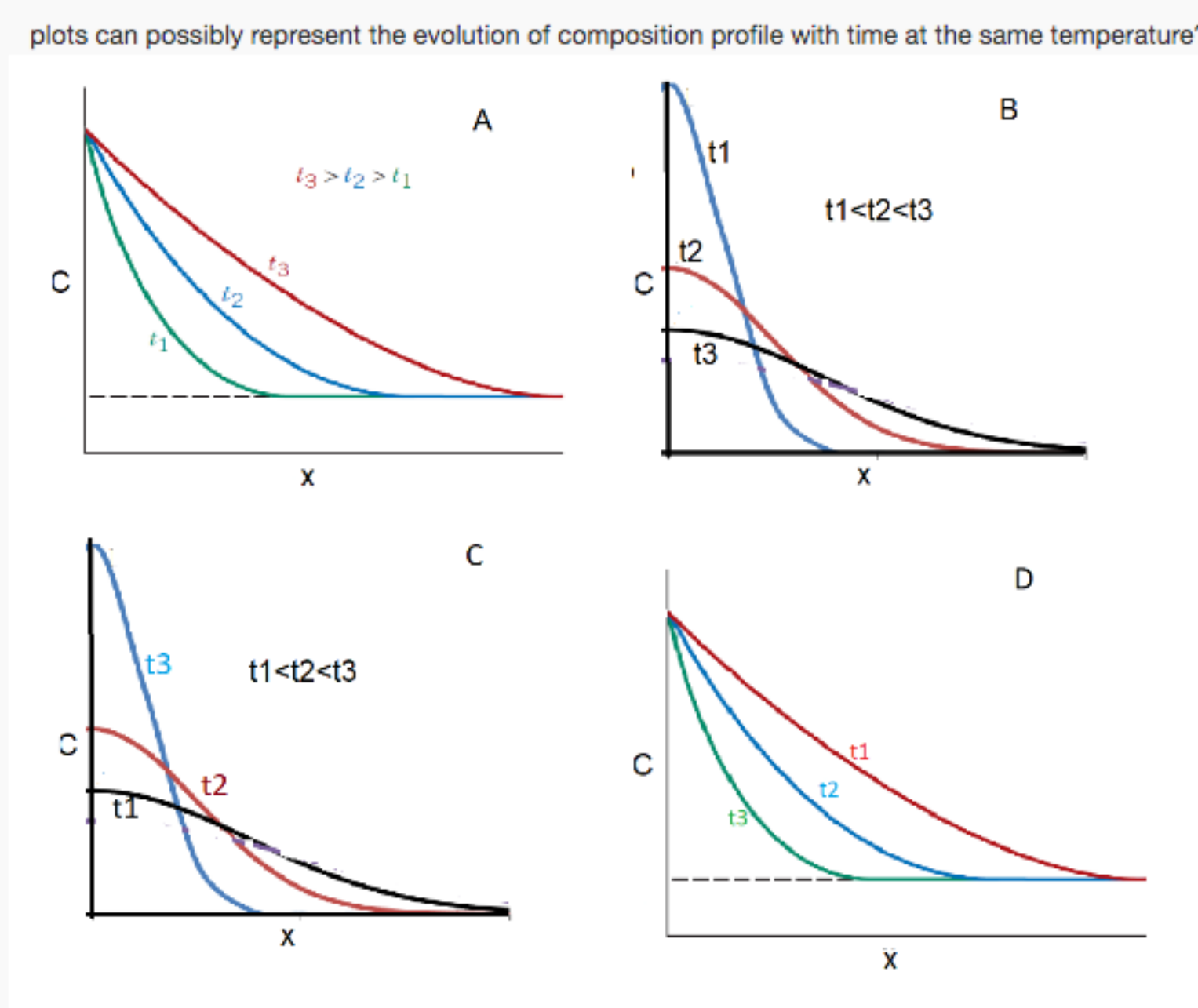

Figure 2: Concentration profiles

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
B

7) Consider a case in which liquid metal is exposed to ambient atmosphere and desorption of solute takes place at the surface. If the concentration profile is given by $\frac{C-C_s}{C_\infty - C_s} = \left(\frac{a}{\delta}\right)x + \left(\frac{b}{\delta}\right)x^3$, where C_s is the concentration of solute at the surface, C_∞ is the actual concentration of the liquid metal, x is the distance from surface into the liquid metal,a, b are constants, δ is the film thickness and D is the diffusion coefficient. Find the mass transfer coefficient. *1 point*

- $\frac{D}{\delta}$
- $\sqrt{\frac{D}{\pi t}}$
- $\frac{Da}{\delta}$
- None of the above

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{Da}{\delta}$

8) Consider a case in which liquid metal is exposed to ambient atmosphere and desorption of solute takes place at the surface. If the concentration profile is given by $\frac{C-C_s}{C_\infty - C_s} = \left(\frac{a}{\delta}\right)x + \left(\frac{b}{\delta}\right)x^3$, where C_s is the concentration of solute at the surface, C_∞ is the actual concentration of the liquid metal, x is the distance from surface into the liquid metal,a, b are constants, δ is the film thickness and D is the diffusion coefficient. Assuming the characteristic length scale to $\frac{2\delta}{a}$, find the Sherwood number

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1.9,2.1

1 point

9) Match the following. *1 point*

Non-dimensional number **Physical significance**

1.Prandtl number A. Ratio of momentum diffusivity and thermal diffusivity
2. Sherwood number B. Ratio of momentum diffusivity and solute diffusivity
3. Schmidt number C. Ratio of convective mass transfer to diffusive mass transfer

- 1-A,2-B,3-C
- 1-A,2-C,3-B
- 1-B,2-C,3-A

No, the answer is incorrect.
Score: 0
Accepted Answers:
1-A,2-C,3-B

10) Determine the correctness of the statement or otherwise. *1 point*
Assertion (A): In special cases, Skin friction factor is twice that of Stanton number.
Reason(R): In those cases, Reynold's analogy is applicable.

- Both A and R are true but R is NOT the correct explanation of A
- Both A and R are true and R is the correct explanation of A
- A is false but R is true
- Both A and R are false

No, the answer is incorrect.
Score: 0
Accepted Answers:
Both A and R are true and R is the correct explanation of A

11) Air at $30\ ^oC$ is humidified by flowing over a $1.5m$ long container filled with water. If the velocity is $1m/s$, kinematic viscosity is $5 \times 10^{-5} m^2/s$ and diffusivity is $3 \times 10^{-5} m^2/s$.calculate the mass transfer coefficient (in mm/s), if average Sherwood number is given by $Sh = 0.664 Re^{0.5} Sc^{0.33}$. *Answer up to one decimal place*

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 26,28

1 point

12) Air is humidified by flowing over a long reservoir filled with water. Assume that the following correlation is applicable for this flow regime. *1 point*

$$Sh = 0.664 Re^{0.5} Sc^{0.33}$$

If the velocity is doubled, how does mass transfer from the reservoir to the air change?

- Does not change
- Increases by 41.4%
- Gets doubled
- Increases by four times

No, the answer is incorrect.
Score: 0
Accepted Answers:
Increases by 41.4%

13) The mass transfer coefficient for a sphere of diameter D diffusing out into a fluid is k_m . If the diameter is increased by 10 %, the mass transfer coefficient is given by *1 point*

- $0.1k_m$
- $0.91k_m$
- $1.1k_m$
- $10k_m$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$0.91k_m$

14) Which of the following theories can used to model the transient diffusion of hydrogen from liquid metal to argon gas bubble during rapid degasing of molten metal? *1 point*

- Stagnant Layer approach
- Film Theory
- Higbie's Penetration theory
- Surface renewal theory

No, the answer is incorrect.
Score: 0
Accepted Answers:
Surface renewal theory

15) A liquid metal in a ladle is being degased using bubbling of argon gas through it. The frequency at which the bubbles are produced at the bottom of the ladle is doubled. How does the mass transfer coefficient for the removal of dissolved gas in the liquid metal change? *1 point*

- Gets doubled
- Increases by 41.4 %
- Decreases by 41.4 %
- Gets halved

No, the answer is incorrect.
Score: 0
Accepted Answers:
Increases by 41.4 %