Assignment 7

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment. Due on 2018-09-26, 23:59 IST.

Symbols have usual meaning unless stated otherwise.

Useful data: \( R = 8.314 \, \text{J/(mol. K)} \) \( ; \) \( N_{\text{Av}} = 6.022 \times 10^{23} \, \text{mol}^{-1} \).

Please do not put space before or after the answer in fill in the blank type questions and give the answer up to the mentioned decimal places in the question.

1) If a constant stress is applied and the strain is monitored with time for a viscoelastic material, which of the following is TRUE:

- Strain will develop instantaneously and remain constant thereafter.
- Strain will always increase linearly as long as the stress is applied.
- Strain will increase as long as the stress is applied but rate of strain will change with time.
- If the stress is removed, the strain will instantaneously become zero.

No, the answer is incorrect. Score: 0

Accepted Answers:

Strain will increase as long as the stress is applied but rate of strain will change with time.

2) Which of the following expressions is correct for the Maxwell model of linear viscoelasticity:

- \( \sigma = \eta \frac{\partial \varepsilon}{\partial t} \)
- \( \sigma = \lambda \frac{\partial \varepsilon}{\partial t} \)
- \( \sigma = \eta \frac{\varepsilon}{\partial t} \)
- \( \sigma = \lambda \frac{\varepsilon}{\partial t} \)

1 point

No, the answer is incorrect. Score: 0

Accepted Answers:

\[ \sigma = \lambda \frac{\partial \varepsilon}{\partial t} \]
3) Which of the following expressions is correct for the creep response as predicted by the Kelvin-Voigt model of linear viscoelasticity:

\[ \varepsilon = (\sigma_0/E)[1 - \exp(-t/\tau_0)] \]

\[ \varepsilon = (\sigma_0/E)\exp(-t/\tau_0) \]

\[ d\varepsilon/dt = \sigma_0/\eta \]

No, the answer is incorrect.
Score: 0
Accepted Answers:
\[ \varepsilon = (\sigma_0/E)[1 - \exp(-t/\tau_0)] \]

4) A viscoelastic material is held at a fixed tensile strain of 0.4. The short-term elastic modulus of the material is 4 MPa and the relaxation time is 200 days. Assuming Maxwell model is applicable, the value to which the stress decays after 250 days, rounded to two decimal places, is ________ MPa.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.44,0.47

5) The short-term elastic modulus of the material is 6 MPa and the relaxation time is 250 days. Assuming that the Kelvin-Voigt model describes the creep behaviour of the viscoelastic material, if the material is held at a constant stress of 0.6 MPa, the time when the strain will be 0.05, rounded to the nearest integer, is ________ days.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 171,175
16) The creep compliance for a viscoelastic polymer is given by

\[ J(t) = J_0 [1 - \exp(-t/\tau_0)] \]

where \( J_0 = 5 \times 10^{-9} \text{ m}^2/\text{N} \) and \( \tau_0 = 500 \text{ s} \). If a constant tensile stress of 40 MPa is applied instantaneously at \( t = 0 \) and maintained thereafter, the time after which the strain is 0.15, rounded to the nearest integer, is _______ s.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 690,700

1 point

7) The number of network strands per unit volume in an elastomer is 500 mol/m³. Assuming the affine network model to apply, the work per unit volume required to extend an same elastomer to twice its original length at a temperature of 25°C is (hint: 1 mol = 6.022×10²³).

- 1.239 MJ/m³
- 3.655 MJ/m³
- 6.168 MJ/m³
- 8.532 MJ/m³

No, the answer is incorrect.
Score: 0
Accepted Answers:
1.239 MJ/m³

1 point

8) For biaxial deformation in the x and y directions, with corresponding deformation factors \( \lambda_x = \lambda_y = \lambda \), the deformation factor in the z direction assuming incompressible deformation is

- \( \lambda_z = 1/\lambda \)
- \( \lambda_z = 1/\lambda^2 \)
- \( \lambda_z = 1/\sqrt{\lambda} \)
- \( \lambda_z = \lambda \)

No, the answer is incorrect.
Score: 0
Accepted Answers:
\( \lambda_z = 1/\lambda^2 \)

1 point

9) One of the strain invariants used in the derivation of the Mooney-Rivlin equation is \( I_2 = \lambda_x^2 \lambda_y^2 + \lambda_y^2 \lambda_z^2 + \lambda_z^2 \lambda_x^2 \). For uniaxial deformation, assuming no volume change to take place, if \( \lambda_x = 4 \), the value of \( I_2 \), rounded to two decimal places, is ________.
If a sinusoidally varying stress is applied to a viscoelastic material, the strain is in phase with the stress and oscillates at the same frequency as the stress.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 8.06, 8.07

A linear amorphous polymer has a viscosity of $5 \times 10^6$ Pa.s at 60 °C. The WLF equation describing the variation of viscosity with temperature is

$$\log_{10} \alpha_T = \frac{-17.44(T - T_g)}{51.6 + (T - T_g)}$$

If the glass transition temperature of this polymer is 30 °C, the viscosity of this polymer at its glass transition temperature is

- 1.29 $\times 10^{12}$ Pa.s
- 5.79 $\times 10^{12}$ Pa.s
- 1.29 $\times 10^{12}$ Pa.s
- 5.29 $\times 10^{12}$ Pa.s

No, the answer is incorrect.
Score: 0
Accepted Answers:
1.29 $\times 10^{12}$ Pa.s

The constitutive equation of a shear thinning polymeric liquid is given by:

$$\sigma = m\dot{\gamma}^n$$

If $m = 10^4$ Pa.s$^n$ and $n = 0.35$, the apparent viscosity of the sample, $\eta(\dot{\gamma})$, when the shear rate $\dot{\gamma} = 100$ s$^{-1}$, rounded to the nearest integer, is

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No, the answer is incorrect.