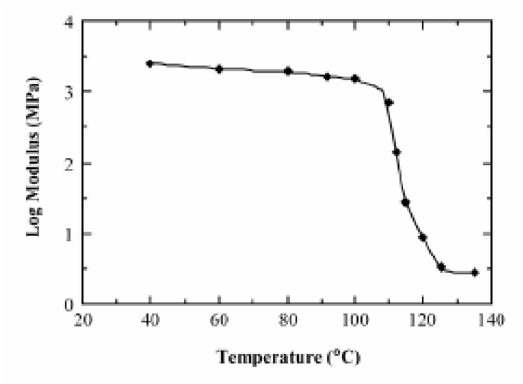
Answers to suggested problems in Chapter 15

5.2
See Sec. 15.4.

15.4



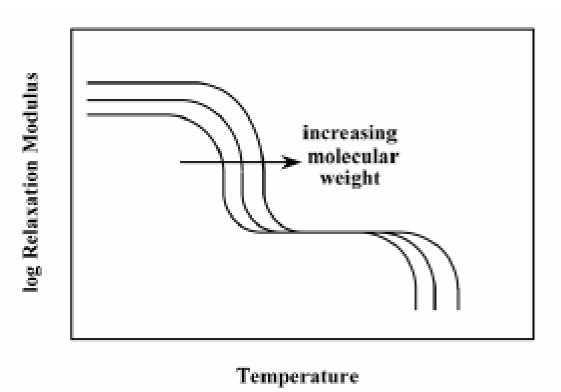
The T_g is that temperature corresponding to the abrupt decrease in log $E_r(10)$, which for PMMA is ~105 °C.

15.6
(a)
Stress relaxation test: sample is rapidly and elastically strained (in tension), strain held constant, and stress measured as a function of time.

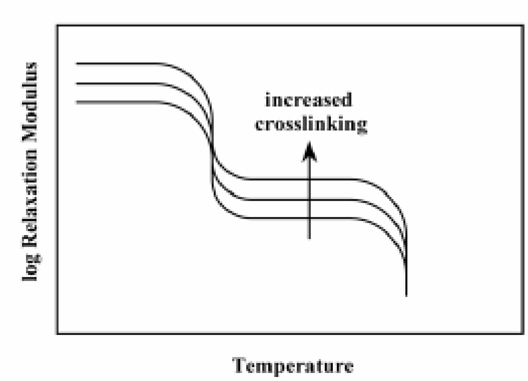
Creep test: stress (usually tensile) is applied instantaneous and held constant while strain is measured as a function of time.

(b)
Stress relaxation test: relaxation modulus (the ratio of stress measured after 10 s and strain); Equation 15.1
Creep test: creep modulus (the ratio of stress and stain taken at a specific time); Equation 15.2

15.7
(a) As molecular weight increases, T_g and T_m of a polymer increases (before finally reaching a plateau); thus:



(b) As crosslink density increases, there is an increase in modulus of both glassy and rubbery regions.



15.10
(a) and (b): see Sec. 15.7
(c): see Sec. 15.9

15.11
a. E in not directly influence by polymer MW
b. E increases with increase degree of crystallinity (enhanced interchain interaction via secondary intermolecular F's)
c. Drawing increases E (along the tensile axis) (produces highly aligned, orientated structure with enhanced interchain interaction)
d. When an undeformed semicrystalline polymer is annealed, E increases (crystallinity increases)
e. When a drawn semicrystalline polymer is annealed, E *decreases* (crystallinity decreases)

15.12
a. TS increases with increased polymer MW due to enhanced chain entanglements
b. TS increases with increase degree of crystallinity (enhanced interchain interaction via secondary intermolecular F's)
c. Drawing increases TS (produces highly aligned, orientated structure with enhanced interchain interaction)
d. When an undeformed semicrystalline polymer is annealed, TS increases

5.16 (done in class)
a. Crystallinity is enhanced with isotactic and unbranched polymers; enhanced crystallinity increases E ---Thus, isotactic linear PVC will have higher E. (Note, MW does not impact E).
b. This question is omitted and replaced to fit lecture: "5% crosslinked PS vs 10% crosslinked PS". Increased crosslinking increases E---Thus, 10% crosslinked PS will have higher E.
c. Not possible to determine. Both branching and atacticity leads to decreased crystallinity (as does increased MW). Although increased crystallinity will increase E, we cannot predict which will be more crystalline.

15.17 (done in class)

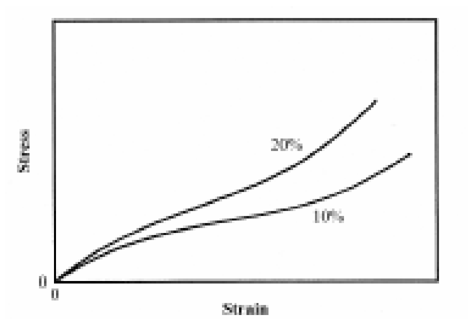
a. TS increases with enhanced crystallinity and MW. Crystallinity is enhanced with isotactic and unbranched (linear)polymers. Thus, isotactic linear PVC (which also has higher MW) will have higher TS.

b. This question is omitted and replaced to fit lecture: "5% crosslinked PET vs 10% crosslinked PET". Increased crosslinking increases TS---Thus, 10% crosslinked PET will have higher TS.

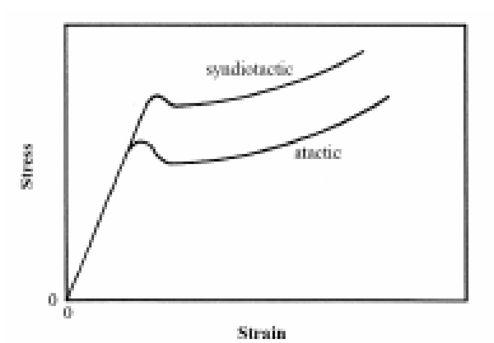
c. This question is omitted and replaced to fit lecture: "linear PET vs branched PET". Branching decreases crystallinity. Since TS increases with enhanced crystallinity, linear will have higher TS.

5.19 (done in class)

a. 20% crosslinked: higher E, higher TS, lower %EL (due to higher crosslink density)

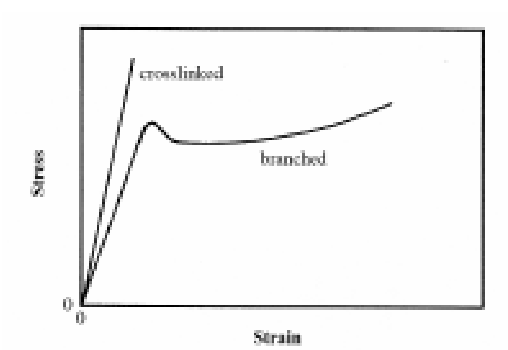


b. Syndiotactic: higher E, higher TS, lower %EL (due to higher M_w and higher crystallinity)



Error with figure: E should also be increasing at all strains for syndiotactic

c. Heavily crosslinked PE: brittle behavior
Branched PE: plastic behavior



15.20

Most elastomers are lightly crosslinked* and amorphous chains between crosslinks exist in their "rubbery state" (i.e. their T_g is below RT) such that there are extensively coiled and kinked in an unstressed state. (*Note: some elastomers are thermoplastic and exhibit physical crosslinking; these are referred to as thermoplastic elastomers, TPE's; unless otherwise specified, questions regarding elastomers refer to the former type—chemical crosslinked).