Materials Science Answer Sheet

Team Name: KEY

1. $A = \frac{\pi}{4} d^2$

   $Creep = A(t) - A_{initial}$ (this is given in problem statement)

   2 points for correct area calculations
   3 points for correct force calculations

2. 1 point for correct axes labels and units
   2 points for proper plotting of data from (1)

   $Creep\ Rate = \frac{\Delta Creep}{\Delta Time}$

   1 point for drawing appropriate trendline (or setting up regression equation)
   1 point for correct calculation of creep rate

3. D 4. B 5. C (2 each)

6. $F = mg$ $g = 9.81\ m/s^2$

   $\sigma = \frac{F}{A}$ $A = \frac{\pi}{4}(0.000511\ m)^2$

   $\varepsilon = \frac{x}{l}$

   1 point for correct calculation of force
   2 points for correct calculation of stress
   2 points for correct calculation of strain

7. 1 point for correct axes labels and units
   2 points for proper plotting of data from (6)
   $E = \frac{\sigma}{\varepsilon}$
   1 point for drawing appropriate trendline (or setting up regression equation)
   1 point for calculation of modulus

8. 3 (4 OK) 9. A (2 each)

10. Rubber, Pine, Aluminum, Rubber (2)

11. a. Composite

b.Polymer

c. Ceramic

d. Composite

e. Metal

f. Polymer (1 each)

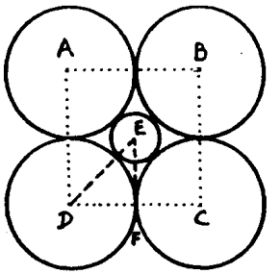
12. A 13. B 14. C

15. D 16. C 17. D

18. B 19. C 20. B

21. C (2 each)

22.



ΔEDF is a right-angled triangle. Using Pythagoras theorem,

$(ED)^2 = (EF)^2 + (DF)^2$

$(r+R)^2 = R^2 + R^2$

$= 2R^2$

$r + R = \sqrt{2}R$

$r = (\sqrt{2} - 1)R$

$= 0.414\ R$

$\frac{r}{R} = 0.414$

Hence, the minimum r/R ratio for C.N. = 6 to be stable is 0.414.

2 points for setting up correct Pythagorean Theorem Equation
2 points for correctly substituting r and R
1 point for correct answer

23. A 24. B 25. A

26. C 27. A 28. B

29. A 30. D 31. C (2 each)

32.

$(\sqrt{2})a = 4r$

$a = 4r/\sqrt{2} = 4\ (1.28\ Å)/\ \sqrt{2} = 3.62Å$

2 points for identifying correct relationship and equation
2 points for correct substitutions
1 point for correct solution

33.

Packing factor = $4\ (4/3)\ \pi r^3/a^3 = 4\ (4/3)\ \pi r^3/(4r/\sqrt{2})^3 = 4(4/3)\pi/[64/(2\sqrt{2})] = 0.74$

1 point for correctly calculating volume of copper atom
1 point for identifying number of copper atoms in unit cell (4)
1 point for correctly calculating volume of unit cell based on result from 32
1 point for setting up correct packing factor equation
1 point for correct answer

34. {1 1 1} (1)

35. D 36. B 37. A

38. B (2 each)

TIEBREAKERS:

1. Combined total of 1, 2, 6, 7.
2. Problem 33
3. Problem 22
4. Percent Difference between answer to 7 and known value