ENME 314 Fluids Tutorial problems 2 Concepts

In these solutions, a full stop between numbers indicates multiplication i.e. 10.2=20

1. A mass
2. 20kg.9.81N/kg=200N (2s.f.)
3. 20. Kg / 0.4536= 44 lbs

4. $\boxed{\lambda = \frac{kT}{\sqrt{2}\pi d^2 p}}$ =2.3x10^{-8} m

5. a. $\underline{v} = 3 \times 1\underline{\hat{\imath}} + 5 \times 2\underline{\hat{\jmath}} + z \times 0\underline{\hat{k}} = 3\underline{\hat{\imath}} + 10\underline{\hat{\jmath}} m/s$

   b. 10 m/s

6. $B \approx -V\frac{\Delta p}{\Delta V}$ or $\Delta p \approx -B\frac{\Delta V}{V}$ i.e. pressure must decrease for volume to increase.

   $\Delta p \approx -B\frac{\Delta V}{V}$

   = -513000 Pa [(5.8 ml)/(10^6 ml/m^3)]/1.15 m^3) = <u>-2.5873 Pa</u>

   or <u>-2.6 Pa</u> to the correct number of significant figures (SF)

7. 1m^3.1000kg/m^3.9.81N/kg=9800N (2s.f.)
8. Mass is 4896.2N/9.81N/kg=499.kg, density is 499kg/0.5m^3=998kg/m^3 (2s.f.) so temperature is 20°C (closest match on the supplied table)
9. 1.164kg/m^3
10. 965.3 kg/m^3
11. $p = \rho R'T$ P=202,650Pa, T=373K (must convert to Kelvin!), R'=specific gas constant 287JK^{-1}kg^{-1} for dry air, so ρ=1.89kgm^{-3} (3 s.f.)

12. Must be drilled at right angles to the pipe wall, free of burrs with nothing protruding into the pipe, and closed at one end by the pressure gauge.

13. P=-ρgz=-1000kg/m^3.9.81N/kg.(-1m)=10,000Pa (1s.f.)
14. Piezometric pressure= p(z)+ρgz=p_o=atmospheric pressure=101,325Pa. The piezometric pressure is the same at both heights: it does not vary with height.

15. 5.0 kph=1.4ms^{-1} $p = \rho R'T$ P=101,325Pa. T=293K must convert to Kelvin. R'=specific gas constant 287JK^{-1}kg^{-1} for dry air. So ρ=1.20kgm^{-3}. Dynamic pressure=$\frac{1}{2}\rho u^2$=1.2Pa to 2.s.f.

16. $\Delta p = \rho V^2/2$ or $V = [2(\Delta p)/\rho]^{0.5}$ = [2(20. kPa)/998.2 kg/m^3] = 6.3303 m/s

= <u>6.3 m/s (2 SF)</u>

17. P_{static}=101,325Pa. ½ρV^2=0.5 x 1.2 x 100^2=6,000Pa. $P_{stagnation}$=101,325Pa+6,000Pa=107,000 Pa (2s.f.)
18. P_{static}=1m x 1000 x 9.81=9810Pa. ½ρV^2=0.5 x 1000 x 10^2=50,000Pa. $P_{stagnation}$=9,810Pa+50,000Pa=60,000Pa (2s.f.)

19. 101325+120=101,445Pa abs
20. 200,000-101325=98,675Pa g
21. 90,000-101325=-11,325Pa g (negative: vacuum): answer should be written -11,300Pa g (3 s.f.)

22. 100,000 Pa/9810 N/m^3=10.2 m or 10 m to 1 s.f.

23. Spanwise
24. Streamwise

25. If you've found the data, you will know the answer now!
26. Water- yes. Ketchup- no: it's thixotropic.

27. It depends on how fast the milk moves. If you pour it in quickly, you see eddies of milk growing and splitting into smaller eddies, and it mixes quickly. This indicates a turbulent flow. If you pour it very slowly, you don't see these eddies and it takes a long time for the milk to mix into the tea, as the mixing is occurring mostly by diffusion.
28. Re=1.2kg/m^3.2.0m.3.0m/s/1.8x10^{-5} Pa.s=400,000
29. Re=1.2kg/m^3.0.15m.3.0m/s/1.8x10^{-5} Pa.s=30,000. Re>4,000 so this is turbulent.

30. Unsteady.
31. Unsteady (as the speed is changing) and 2D.

32. It can't be a free vortex, as the spoon is forcing the rotation; if stirred at constant speed there will be a forced vortex with solid body rotation. At the wall of the cup the no-slip condition will hold, so it will be like a Rankine vortex, or more realistically a Lamb-Oseen vortex, as tea has viscosity.

33. A=3.141.(0.080m)^2/4=5.0x10^{-3} m^2. Drag force=0.45.5.0x10^{-3} m^2.0.5.1.2kgm^{-3}.(10m/s)^2=0.14 N