1. (4 points) In the compression chamber of a diesel engine the volume of a gas mixture initially at 27°C is compressed by a factor of 20 ($V_{\text{Final}} = 1/20V_{\text{Initial}}$). If the pressure increases from 1 atmosphere to 50 atmospheres, what is the final temperature?

(1) 477°C  (2) 954°C  (3) 273°C  (4) 0°C  (5) 1430°C

2. (5 points) A misshapen lump of metal is weighed in air and then weighed while immersed in oil of density 800 kg/m$^3$. If the weight in air is 2.2 kg and the weight in the oil is 1.2 kg, calculate the density of the metal.

(1) 1760 kg/m$^3$  (2) 2650 kg/m$^3$  (3) 92 kg/m$^3$  (4) 36.8 kg/m$^3$  (5) 13.5 kg/m$^3$

3. (4 points) A 5 meter length of steel with a cross-sectional area of 20 cm$^2$ is compressed with a force of 20,000 N. If the Young’s modulus of steel is $200 \times 10^9$ N/m$^2$, what is the change in length of the steel beam?

(1) 0.25 mm  (2) 2.5 cm  (3) 5.5 cm  (4) 0.11 cm  (5) 12.5 mm

4. (5 points) A cylinder of radius $b$ has a moment of inertia $I = (1/2)mb^2$. The cylinder is rolled along a flat horizontal surface at speed $v$ so that when it hits a ramp, it will travel to a height of 50 cm and then stop. What is the initial speed $v$ of the cylinder?

(1) 2.6 m/s  (2) 5.25 m/s  (3) 12.2 m/s  (4) 1.22 m/s  (5) 52.5 m/s

5. (4 points) An object has a moment of inertia of 2.56 kg·m$^2$. What is the value of the torque needed to accelerate the rotation of the object from rest to a rotation of 5 revolutions per second in 30 seconds?

(1) 2.68 N·m  (2) 1.34 N·m  (3) 0.27 N·m  (4) 4.02 N·m  (5) 0 N·m

6. (4 points) A 5 m$^3$ tank of compressed helium gas has an absolute pressure of 4 kPa at a temperature of 27°C. What is the mass of the helium in the tank? 1 kmole of helium weighs 4 kg.

(1) 33 g  (2) 13.5 g  (3) 1.61 kg  (4) 0.35 kg  (5) 6.42 kg
7. (4 points) A 100 meter length of steel changes temperature by 30°C during the course of a day. If the coefficient of thermal expansion of steel is 12 parts per million per °C, what is the change in length of the steel?

(1) 3.6 cm (2) 7.2 cm (3) 14.4 mm (4) 1.8 m (5) 0.18 cm