This print-out should have 10 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

**Rising to the Surface**

**001 10.0 points**

A scuba diver has her lungs filled to half capacity (1 L) when she is 11 m below the surface.

The acceleration of gravity is 9.8 \( \text{m/s}^2 \).

If the diver holds her breath while quietly rising to the surface, what will be the volume of her lungs (in liters) at the surface?

Correct answer: \( \boxed{2} \) L.

**Pendulum Changes Length**

**002 10.0 points**

A clock has a 1 m bronze pendulum which is accurate at a temperature of 15\(^\circ\)C.

What is the change in the length of the pendulum when the temperature reaches 44.0318\(^\circ\)C? (The linear expansion coefficient of bronze is \( 1.9 \times 10^{-7} \text{/(°C)}^{-1} \).)

Correct answer: 0.00551604 mm.

**Expansion Joints**

**003 10.0 points**

A bridge is made with segments of concrete 88 m long (at the original temperature).

If the linear expansion coefficient is \( 1.2 \times 10^{-5} \text{/(°C)}^{-1} \), how much spacing is needed to allow for expansion for an increase in temperature of 42\(^\circ\)F?

Correct answer: 2.464 cm.

**Gasoline Expansion**

**004 10.0 points**

The density of gasoline is 730 kg/m\(^3\) at 0\(^\circ\)C. One gallon of gasoline occupies 0.0038 m\(^3\). Gasoline’s volume expansion coefficient is 0.00096 \((\text{°C})^{-1}\).

How many extra kilograms of gasoline are obtained when seven gallons of gasoline are bought at 0\(^\circ\)C rather than at 22\(^\circ\)C (temperature at the filling station)?

Correct answer: \( \boxed{0.00653} \) kg.

**Cooling Car Engine**

**005 10.0 points**

A 285 kg cast-iron car engine contains water as a coolant. Suppose the engine’s temperature is 33\(^\circ\)C when it is shut off and the air temperature is 13\(^\circ\)C. The heat given off by the engine and water in it as they cool to air temperature is \( 3.5 \times 10^6 \text{J} \).

What mass of water is used to cool the engine? The specific heat of water is 4180 J/kg \cdot \text{°C} and of iron 450 J/kg \cdot \text{°C}.

Correct answer: 11.1842 kg.

**Bullet Into Wall**

**006 10.0 points**

A cowboy fires a silver bullet of mass 4 g with a muzzle speed of 219 m/s into the pine wall of a saloon.

What is the temperature change of the bullet? Assume that all the internal energy generated by the impact remains with the bullet. The specific heat of silver is 234 J/kg \cdot \text{°C}.

Correct answer: 102.481\(^\circ\)C.

**Melting Ice**

**007 10.0 points**

In an insulated vessel, 307 g of ice at 0\(^\circ\)C is added to 660 g of water at 13\(^\circ\)C.

How much ice remains when the system reaches equilibrium? Assume the heat of fu-
tion of ice is 79.7 cal/g and its specific heat is 0.5 cal/g·°C. The heat of vaporization of water is 540 cal/g and its specific heat is 1 cal/g·°C.

Correct answer: g.

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**Water to Ice**  
**008  10.0 points**

A 62 g ice cube at −20°C is dropped into a container of water at 0°C.

How much water freezes onto the ice? The specific heat of ice is 0.5 cal/g·°C and the heat of fusion of is 80 cal/g.

Correct answer: 7.75 g.

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**Nail Into Ice**  
**009  10.0 points**

An iron nail is driven into a block of ice by a single blow of a hammer. The hammerhead has a mass of 0.2 kg and an initial speed of 2.2 m/s. Nail and hammer are at rest after the blow.

How much ice melts? Assume the temperature of both the ice and the nail is 0°C before and after. The heat of fusion of ice is 80 cal/g.

Correct answer: 0.00144529 g.

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**Water Equilibrium 03**  
**010  10.0 points**

A calorimeter contains 486 mL of water at 53°C and 49 g of ice at 0°C.

Find the final temperature of the system. The specific heat of water is 1 cal/g·°C and the latent heat of fusion of water is $3.33 \times 10^5$ J/kg.

Correct answer: 40.8596°C.