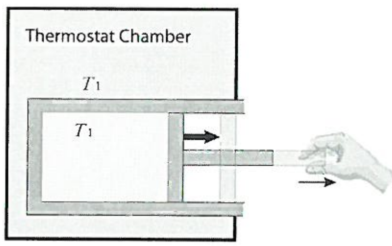
student 8
Average 32.3/50
Best 44.0/50

12th Physics (2017 – 18)

(3rdQ, #1 Mini Test)

Class	No.	Name Solutions



In calculation problems, describe equations clearly and systematically enough to show how to solve the problems. If not enough, you won't get any point.

4 pt/question x 13 questions = 52 pt Max 50 pt

／[Total 50 points]

Gravitational acceleration rate	$g = 9.80\ m/s^2$
Atmospheric Pressure	$1.00\ atm = 1.013 \times 10^5\ Pa$
Avogadro's Number	$N_A = 6.022 \times 10^{23}$ molecule / mol
Universal Gas Constant	$R = 8.31\ J/(mol \cdot K)$
Boltzmann Constant	$k = 1.38 \times 10^{-23}\ J/K$

Density	[kg/m³]
Gold	19,300
Silver	13,600
Iron	7,860
Sea water	1,025
Water	1,000
Ice	917
Air	1.29
Helium	0.179
Hydrogen gas	0.0899

Specific Heat c	[J/(kg・K)]
Water	4186
Ice	2090
Steam	2010
Oil	1970
Copper	387
Ceramic	1090
Glass	837
Aluminum	900
Iron (Steel)	560
Lead	128

	Latent Heat of Fusion L_f [J/kg]	Latent Heat of Vaporization L_v [J/kg]
Water	3.35×10^5	22.6×10^5

(1,2) A cylindrical flask is fitted with an airtight piston that is free to side up and down, as shown the figure. A mass rests on top of the piston. The initial temperature of the system is 40.0℃ and the pressure of the gas is held constant at 137 kPa.

(1) The temperature is now increased until the height of the piston rises from 23.4 cm to 26.0 cm. What is the final temperature of the gas?

(2) The initial conditions are 40℃ and 137 kPa. When additional mass is added to the piston, the height of the piston decreases from 23.4 cm to 20.0 cm. Find the new pressure applied by the piston.

(Equations)

(1) Charles's Law $\frac{V}{T} = \frac{V'}{T'}$

$T = 40.0° + 273.15°$

$= 313.15°$

$T' = T \times \frac{V'}{V} = 313.15 \times \frac{26.0 \times A}{23.4 \times A} = \overline{347.94}$

$\overline{347.94} - 273.15 = \overline{74.79} \rightarrow 75\ (°C)$

(2) Boyle's Law $PV = P'V'$

$P' = P \cdot \frac{V}{V'} = 137 \times 10^3 \times \frac{23.4\ A}{20.0\ A} = \overline{160.3} \times 10^3 \rightarrow 160 \times 10^3\ (Pa)$

(1) Answer

75 ℃

(61%)

(2) Answer

160 kPa

(88%)

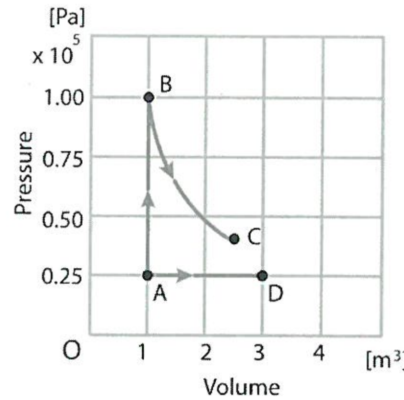
(3,4) An ideal gas is confined within a container. The pressure and volume of the gas is changed as shown, A → B→ C.

(3-a) The temperature at A is 3.0 x 10^2 K. Find the amount of the gas by mole.

(3-b) Find the temperature at B.

(4-c) The state of the gas is changed form B to C by keeping the temperature unchanged. The volume at C is 2.5 m^3. Find the pressure at C.

(4-d) In the previous problem, the pressure of the state D is the same as that of the state A. The volume of D is 3.0 m^3. Find the temperature at D.



(Equations)

$P = 0.25 \times 10^5$ Pa , $V = 1.0$ m^3

(a) $T = 3.0 \times 10^3$ K

$PV = nRT \rightarrow n = \frac{PV}{RT} = \frac{0.25 \times 10^5 \times 1.0}{8.31 \times 3.0 \times 10^2}$

$= 0.0100 \times 10^{5-2}$

$= 10.0 \rightarrow 10$

(b) $T = \frac{PV}{nR} = \frac{1.0 \times 10^5 \times 1.0}{10.0 \times 8.31} = 0.120 \times 10^4 = \bar{1}.20 \times 10^3$(K)

(c) Boyle's law $PV = P'V'$

$P' = P\frac{V}{V'} = 1.0 \times 10^5 \times \frac{10}{2.5} = \bar{4}.00 \times 10^4$

(d) Charles's law

$\frac{T}{V} = \frac{T'}{V'}$

$T' = T\frac{V'}{V}$

$= 3.0 \times 10^2 \times \frac{3.0}{1.0}$

$= 9.0 \times 10^2$

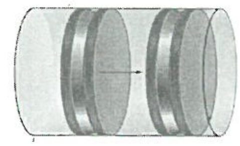
(3-a) Answer	10 mol
(3-b) Answer	1.2×10^3 K

(81%)

(4-c) Answer	4.0×10^4 Pa
(4-d) Answer	9.0×10^2 K

(61%)

(5,6) An ideal gas with a pressure of 1.2×10^5 Pa is confined in a cylinder with a piston having a cross-sectional area of 1.0×10^{-2} m^2. The amount of heat, 2.0×10^{-4} J is added to the cylinder and then the gas expands at constant pressure so that the piston moves outside by 50.0 cm .



(5-a) How much work does the outside air do?
(5-b) How much work does the piston do? on the

(Equations)

$W = p\Delta V = 1.2\times10^5 \times 50.0\times10^{-2} \times 1.0\times10^{-2}$

$= 60.0\times10 = 600$

(5-a) Answer
-600 J
(5-b) Answer
600 J

(68%)

(6) A cylinder contains 4.0 moles of a monatomic gas at an initial temperature of 27℃. The gas is compressed by doing 560 J of work on it, and its temperature increases by 130℃. How much heat flows into or out of gas?

$n = 4.0$ mol $\quad T = 27^\circ C \quad \Delta T = 130^\circ$

$W = -560$ J

$\Delta U = Q - W$

$\Delta U = n C_v \Delta T$

$= 4.0 \cdot \frac{3}{2}R \cdot 130 = 4.0 \times \frac{3}{2} \times 8.31 \times 130$

$= 6482$

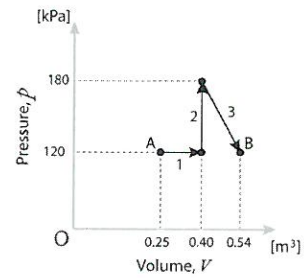
$Q = \Delta U + W$

$= 6482 - 560 = 5922$

(6) Answer
5.9×10^3 into gas

(30%)

(7) A fixed quantity of gas undergoes the changes from the state A to B through the three-step processes, 1 ~ 3, illustrated in the diagram. Find the total work done by the gas.
(Equations)

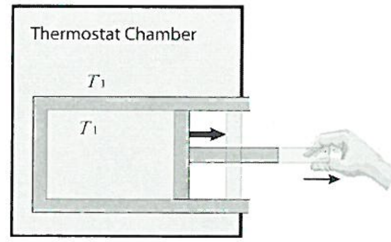


$$W = 120\times10^3 \times (0.54-0.25)$$
$$+\frac{1}{2}(180-120)\times10^3\times(0.54-0.40)$$
$$= 34.80\times10^3 + 4.20\times10^3$$
$$= 39.0\times10^3 \rightarrow 3.9\times10^4$$

(7) Answer
3.9×10^4 J

(72%)

(8) 9.00 moles of a monatomic ideal gas at a temperature of 251 K are expanded isothermally from a volume of 1.12 L to a volume of 4.33 L.
(8-a) Find the work done.
(8-b) Find the heat flow into or out of the gas.
(Equations)



(a) $n = 9.00$ mol
$T = 251$ K
$V = 1.12$ L , $V' = 4.33$ L

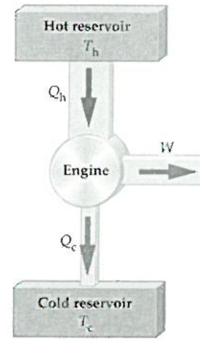
$W = nRT \ln(V'/V)$
$= 9.00 \times 8.31 \times 251 \ln(4.33/1.12)$
$= 25385 \rightarrow 2.54 \times 10^4$

(b) $\Delta U = Q - W$
$\Delta U = 0$
$Q = W$

(8-a) Answer
2.54×10^4 J

(8-b) Answer
2.54×10^4 J into gas (52%)

(9) The efficiency of a particular Carnot engine is 0.300. If the high-temperature reservoir is at a temperature of 555K, what is the temperature of the low-temperature reservoir?
(Equations)



Carnot engine $e = 1 - \frac{T_c}{T_h}$

$e = 0.300$

$T_h = 555$

$\frac{T_c}{T_h} = 1 - e \rightarrow T_c = T_h(1-e)$

$= 555(1-0.300)$

$= 388.5 \longrightarrow 388$

(9) Answer
388 K

(95%)

(10) On a cold winter's day heat leaks slowly out of house at the rate of 22.0 kW. If the inside temperature is 25 ℃, and the out side temperature is −15.5℃, find the rate of entropy change.

$273.15 + 25 = 298.15$ $273.15 - 15.5 = 257.65$

$\Delta S_h = -\frac{Q_h}{T_h} = -\frac{22000}{298.15} = -73.79$

$\Delta S_c = \frac{Q_c}{T_c} = \frac{22000}{257.65} = 85.39$

$\Delta S_{Total} = \Delta S_h + \Delta S_c$

$= -73.79 + 85.39$

$= +11.60$

$\rightarrow 12$ (J/K/s)

(10) Answer
12 W/K

(70%)

(11) A reversible refrigerator with a coefficient of performance of 5.0 is used to keep a temperature of 3.0℃ inside in a kitchen at 26℃ using a mechanical work of 86 kJ.

(11-a) Find the rate of heat removed from the refrigerator.

(11-b) Find the rate of entropy change in this system.

(Equations)

Fridge $3.0°C = 276.15 K$

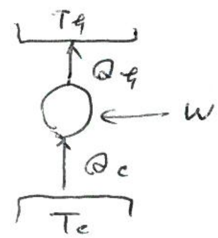
Kitchen $26°C = 299.15 K$

86 kJ supplied.

$COP = 5.0$

$$COP = \frac{Q_c}{W} \rightarrow Q_c = 5.0 \times 86 (kJ) = 430 (kJ)$$

$$Q_h = Q_c + W = 430 kJ + 86 kJ = 516 kJ$$



$$\Delta S_c = -\frac{430 \times 10^3}{276.15} = -\overline{1.557} \times 10^3$$

$$\Delta S_h = \frac{516 \times 10^3}{299.15} = \overline{1.725} \times 10^3$$

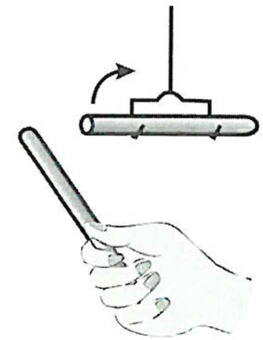
$$\Delta S_{Total} = \Delta S_c + \Delta S_h$$

$$= 0.\overline{1}68 \times 10^3 \ J/K$$

$$\rightarrow 200 \ J/K$$

(11-a) Answer	430 kW
(11-b) Answer	200 W/K

(30%)



(12) A charge rod is brought near a suspended object , which is repelled by the rod. Can we conclude that the suspended object is charged? Explain.

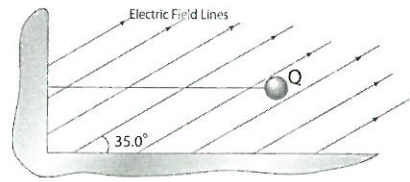
(12) Answer

Yes, we can. If the object is a neutral insulator, it is attracted by the rod because the insulator is charged by polarization. If the object is a neutral metal (conductor) it is attracted by the rod because the metal is charged by induction.

That is to say, all the neutral objects are attracted by a charged rod. If the object is repelled, it has the same charge with the charge of the rod

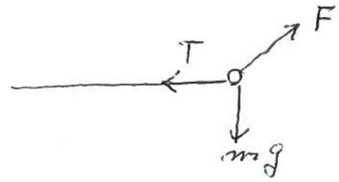
(55%)

(13) An object of mass m=3.10 g and Q=+48.0 μC is attached to a string and placed in a uniform electric field that is inclined at an angle of 35.0° with the horizontal. The object is in static equilibrium when the string is horizontal. Find the magnitude of the electric field.
(Equations)



$F = qE = 48.0\times10^{-6} E$ (N)

$mg = 3.10\times10^{-3}\times 9.80 = 30.38\times10^{-3}$ (N)



$mg = F\sin 35°$

$30.38\times10^{-3} = 48.0\times10^{-6}\sin 35°\cdot E$

$E = \dfrac{30.38\times10^{-3}}{48.0\times10^{-6}\sin 35°}$

$= 1.103\times10^{3}$

(13) Answer

1.10×10^{3} N/C (45%)