Q1.
A string of length 50 cm and of linear mass density 0.200 g/cm is fixed at both ends. The string is under tension of 800 N. What is its fundamental frequency?

A) 200 Hz
B) 800 Hz
C) 600 Hz
D) 100 Hz
E) 400 Hz

Q2.
A point source emits sound isotropically. The sound level is 80.0 dB at a distance of 10.0 m from the source. What is the average power of the source?

A) 126 mW
B) 56.5 mW
C) 28.3 mW
D) 113 mW
E) 315 mW

Q3.
What is the minimum amount of heat required to completely melt 10 g of aluminum initially at 25 ^{o}C. For aluminum, c = 900 J/kg.K, $L_f = 3.97\times10^5$ J/kg, and it melts at a temperature of 660 ^{o}C.

A) 9.7 kJ
B) 4.7 kJ
C) 5.7 kJ
D) 6.8 kJ
E) 4.0 kJ

Q4.
How much work is required to compress three moles of an ideal gas at 25 ^{o}C and 1.0 atmosphere to half of its initial volume during an isothermal process?

A) –5.2 kJ
B) –4.3 kJ
C) –2.2 kJ
D) –1.7 kJ
E) Zero

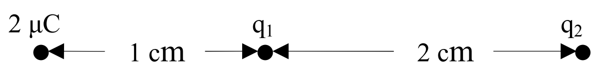
Q5.

Three moles of an ideal monatomic gas are allowed to expand isobarically. The initial volume is 25.0 cm^3 and the final volume is 200 cm^3. Find the change in entropy of the gas.

A) 130 J/K
B) –12.0 J/K
C) 43.2 J/K
D) 15.6 J/K
E) Zero

Q6.
The figure shows three point charges fixed on a straight line. For what values of q_1 and q_2 would the net force on the 2 μC charge be zero?

Fig#



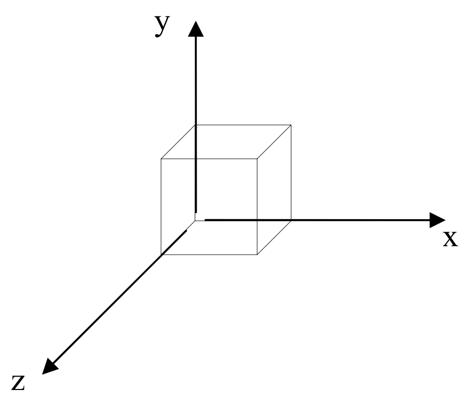
A) $q_2 = -9q_1$
B) $q_2 = 9q_1$
C) $q_2 = 3q_1$
D) $q_2 = -3q_1$
E) $q_2 = -2q_1$

Q7.
A uniform electric field is given by **E** = 500 **i** N/C. What is the net force on a 5.0 μC charge placed at (3.0 m, 4.0 m)?

A) (2.5 mN) **i**
B) (63 mN) **i**
C) –(63 mN) **i**
D) –(2.5 mN) **j**
E) 0

Q8.
A cube of side *l* has one corner at the origin as shown in the figure. The cube is lying in a region where the electric field is **E** = (a+bx) **i**. What is the net charge enclosed by the cube.

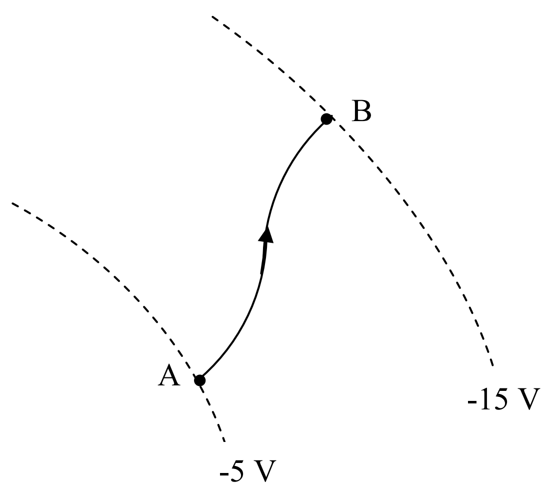
Fig#



A) $\varepsilon_o b l^3$
B) $\varepsilon_o l^2(a+bl)$
C) $\varepsilon_o l^2(a-bl)$
D) $(\varepsilon_o b^2 l^4)/a$
E) 0

Q9.
The figure shows two equipotential (dashed) surfaces such that V_A = -5.0 V and V_B = -15 V. What is the external work needed to move a -2.0 μC charge at constant speed from A to B along the indicated path?

Fig#

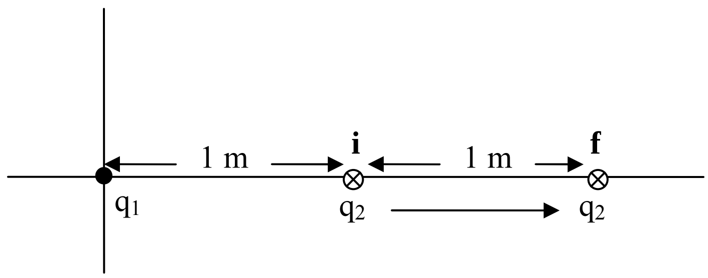


A) 20 μJ
B) 40 μJ
C) -40 μJ
D) -20 μJ

E) 0 μJ

Q10.
How much work is required to move the charge q_2 from the initial position **i** to the final position **f** as shown in the figure? (q_1 = -60 μC and q_2 = 20 μC)

Fig#



A) 5.4 J
B) –5.4 J
C) 11 J
D) 2.5 J
E) –2.5 J

Q11.
A parallel plate capacitor is charged using a battery. While the battery is connected, a dielectric is inserted filling completely the space between the plates. Which of the following statements is CORRECT?

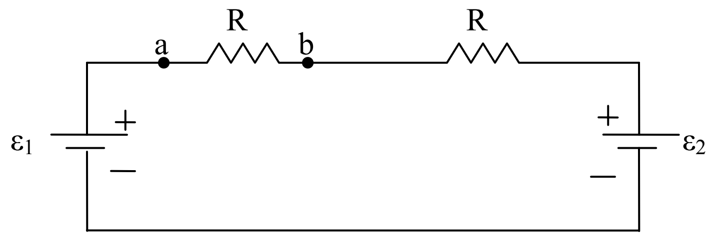
A) The stored energy will increase.
B) The electric field will increase.
C) The charge will decrease.
D) The energy density will remain constant.
E) The potential difference between the plates will increase.

Q12.
A copper wire has a resistance of 2.0 ohms at 20 ^oC. At what temperature is the resistance 15% higher? The temperature coefficient of resistivity of copper is 3.9×10^{-3} $(C^o)^{-1}$.

A) 58 ^oC
B) 29 ^oC
C) 39 ^oC
D) 50 ^oC
E) 40 ^oC

Q13.
The figure shows two resistors, each of the resistance R, connected to two ideal batteries of emf ε_1 and ε_2 ($\varepsilon_1 > \varepsilon_2$). The potential difference $V_a - V_b$ is equal to $\varepsilon_1/5$. What is the ratio $\varepsilon_2/\varepsilon_1$?

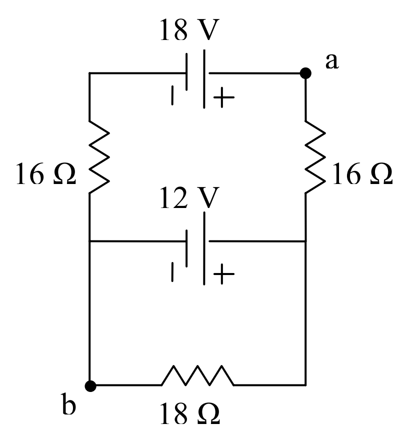
Fig#



A) 3/5
B) 2/5
C) 1/5
D) 4/5
E) 1

Q14.
Three resistors and two batteries are connected as shown in the circuit diagram below. What is the potential difference $V_a - V_b$?

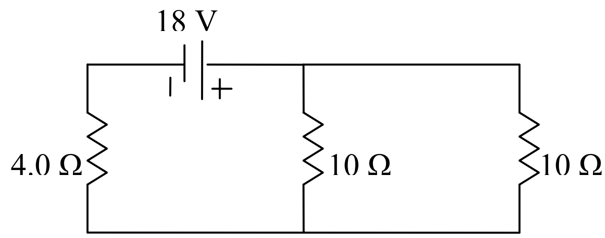
Fig#



A) 15 V
B) 5 V
C) 12 V
D) -12 V
E) 0 V

Q15.
Determine the power dissipated by the 4.0 Ω resistor in the circuit shown.

Fig#



A) 16 W
B) 4.0 W
C) 2.0 W
D) 8.0 W
E) 18 W

Q16.
A capacitor of capacitance C takes 2 s to reach 63 % of its maximum charge when connected in series to a resistance R and a battery of emf ε. How long does it take for this capacitor to reach 95 % of its maximum charge (from zero initial charge)?

A) 6 s
B) 7 s
C) 5 s
D) 3 s
E) 4 s

Q17.
Two resistors have resistances R_1 and R_2, such that $R_1 < R_2$. If R_1 and R_2 connected in…

A) parallel, then $R_{eq} < R_1$ and $R_{eq} < R_2$
B) parallel, then $R_{eq} > R_1$ and $R_{eq} < R_2$
C) parallel, then $R_{eq} > R_1$ and $R_{eq} > R_2$
D) series, then $R_{eq} > R_1$ and $R_{eq} < R_2$
E) series, then $R_{eq} < R_1$ and $R_{eq} < R_2$

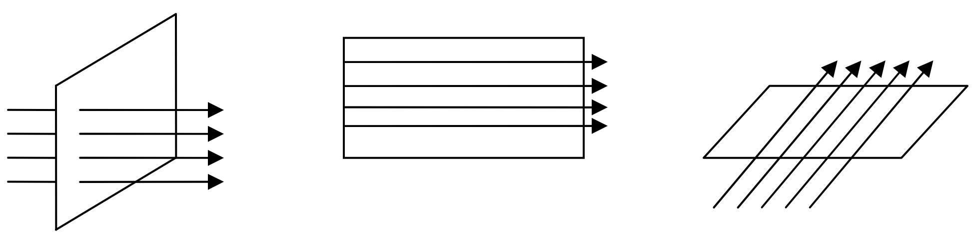
Q18.

A 2.0 C charge moves in a uniform magnetic field with a velocity of (2.0 **i** + 4.0 **j**) m/s and experience a magnetic force of 12 N along the +z-axis. The x component of the magnetic field is equal to zero. Determine the y component of the magnetic field?

A) +3.0 T
B) -3.0 T
C) +5.0 T
D) -5.0 T
E) +6.0 T

Q19.
A current loop is oriented in three different positions relative to a uniform magnetic field. In position 1 the plane of the loop is perpendicular to the field lines. In position 2 and 3 the plane of the loop is parallel to the field lines as shown in the figure. The torque is maximum in:

Fig#



Position 1 Position 2 Position 3

A) positions 2 and 3
B) position 1
C) position 2
D) position 3
E) all three positions

Q20.
A charged particle has a kinetic energy of 10^{-7} joules and moves in a circular path in a uniform magnetic field. If the magnitude of the magnetic force on the particle is 1.5×10^{-4} N, what is the radius of the circular motion?

A) 1.3 mm
B) 2.5 mm
C) 7.0 mm
D) 4.2 mm
E) 3.7 mm

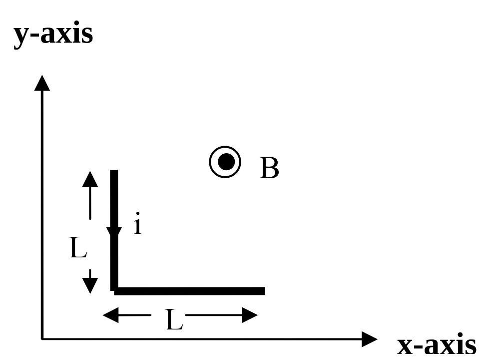
Sec# Magnetic Fields - A Circulating Charged Particle
Grade# 50

Q21.
What is the kinetic energy of an electron that passes in a straight line through perpendicular electric and magnetic fields if E= 4.0 kV/m and B= 8.0 mT ?

A) 0.71 eV
B) 0.65 eV
C) 0.84 eV
D) 0.54 eV
E) 1.4 eV

Q22.
A straight long wire having a total length 2L=10 cm is carrying a current of 10 A. The wire is bent at its mid point to form an angle of 90° with each side of length L. As shown in the figure, the wire is placed in the xy plane in a region where a constant magnetic field of 3.0 mT, out of the page, exists. What is the magnitude of the magnetic force on this wire?

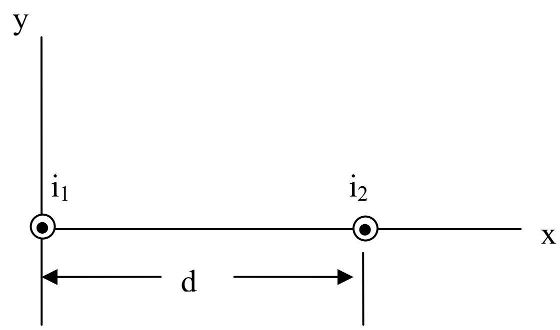
Fig#



A) 2.1x 10^{-3} N
B) 3.2x 10^{-3} N
C) 5.3x 10^{-3} N
D) 4.2x 10^{-3} N
E) 6.0x 10^{-3} N

Q23.
Two long parallel straight wires, at a separation d = 20.0 cm, carry currents i_1 = 3.61 mA and i_2 = 3.00 mA out of the page. At what distance from the origin on the x-axis shown in the figure, is the net magnetic field due to the currents equal zero?

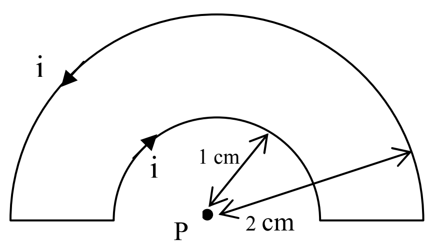
Fig#



A) 11 cm
B) 7.0 cm
C) 15 cm
D) 6.0 cm
E) 9.0 cm

Q24.
What are the strength and direction of the magnetic field at point P (the center of arcs), if the current in the loop is 5.0 A?

Fig#



A) 79 µT into the page
B) 79 µT out of the page
C) 160 µT out of the page
D) 160 µT into the page
E) Zero

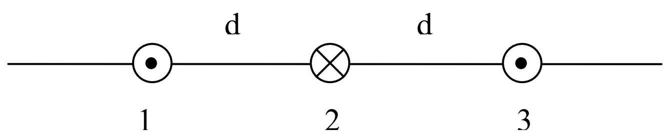
Q25.

A long solid cylindrical wire, of radius R = 2.00 cm carries a uniform current of 1.9 A. Find the magnetic field strength at a distance of 1 cm from the center of the wire.

A) 9.5 μT
B) 1.7 μT
C) 3.4 μT
D) 6.8 μT
E) 7.4 μT

Q26.
The figure shows three wires that are perpendicular to the page. The currents are all equal, two being out of page and one being into the page. Rank the wires according to the magnitudes of the magnetic forces on them, greatest first.

Fig#



A) 1 and 3 tie, then 2
B) 2, then 1 and 3 tie
C) 1, then 2, then 3
D) 2 and 3 tie, then 1
E) 3, then 2, then 1

Sec# Magnetic Fields Due to Currents - Force Between Two Parallel Currents
Grade# 65

Q27.
We wish to generate a 0.10 T uniform magnetic field near the center of a 10 cm long ideal solenoid. What is the minimum number of turns needed, if the wire can carry a maximum current of 10 A?

A) 800
B) 80
C) 65
D) 260
E) 450

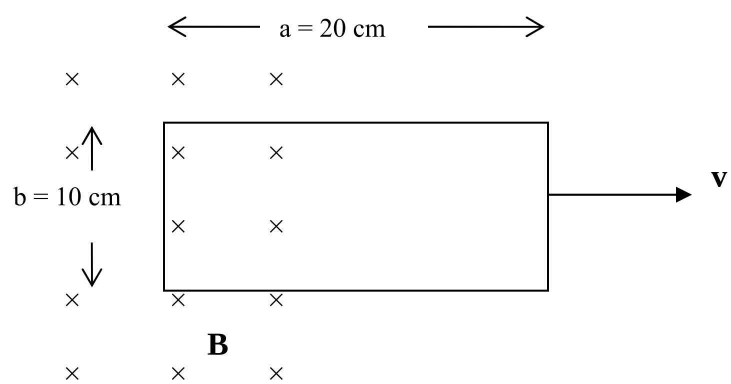
Q28.

A circular loop of radius R = 10 cm is placed so that its plane is perpendicular to a magnetic field that is increasing at a constant rate of 50 mT/s. What is the magnitude of the induced emf in the loop?

A) 1.6 mV
B) 3.2 mV
C) 1.8 mV
D) 0.9 mV
E) 2.2 mV

Q29.
Consider a rectangular conducting loop of length a = 20 cm and width b = 10 cm and resistance R = 10 Ω as shown in the figure. The loop is moving out of a uniform magnetic field region, at a constant speed of 5.0 m/s. The magnetic field **B** is into the page and has a magnitude of 0.50 T. What is the magnitude and direction of the induced current?

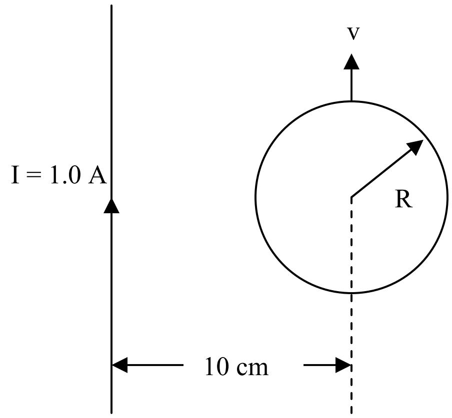
Fig#



A) 25 mA clockwise
B) 25 mA counterclockwise
C) 30 mA clockwise
D) 30 mA counterclockwise
E) 20 mA clockwise

Q30.
A very long straight wire is in the plane of a circular conducting loop of radius R = 2 cm as shown in the figure. The wire carries a current of 1.0 A and has a resistance of 2.0 Ω. The circular loop starts moving parallel to the wire with a speed of 10 m/s as shown. The induced current during the motion of the loop is

Fig#



A) Zero
B) 0.63 μA
C) 0.34 μA
D) 0.22 μA
E) 1.30 μA

Formula sheet for Final Exam

$v = \sqrt{\frac{\tau}{\mu}}$, $v = \lambda f$ $v = \sqrt{\frac{B}{\rho}}$ $S = S_m \cos(kx - \omega t)$	$v_{rms} = \sqrt{\frac{3RT}{M}}$, $\frac{1}{2} m\vec{v}^2 = \frac{3}{2} k_B T$, $P_{cond} = \frac{Q}{t} = \kappa A \frac{T_H - T_C}{L}$	$I = J A$, $R = \frac{V}{I} = \rho \frac{L}{A}$ $\rho = \rho_0 [1 + \alpha(T - T_0)]$, $P = IV$ $q(t) = C\varepsilon[1 - e^{-t/RC}]$,

$I = \frac{\text{Power}}{\text{Area}}$

$y = y_m \sin(kx - \omega t - \varphi)$

$P = \frac{1}{2}\mu\omega^2 y_m^2 v$

$\Delta P = \Delta P_m \sin(kx - \omega t)$

$\Delta P_m = \rho v \omega S_m$

$I = \frac{1}{2}\rho(\omega S_m)^2 v$

$\beta = 10 \log \frac{I}{I_0}$, $I_0 = 10^{-12} W/m^2$

$f' = f\left(\frac{v \pm v_D}{v \mp v_s}\right)$

$y = \left(2y_m \cos\frac{\varphi}{2}\right)\sin\left(kx - \omega t - \frac{\varphi}{2}\right)$

$\Delta L = \frac{\lambda}{2\pi}\varphi$

$\Delta L = n\frac{\lambda}{2}$ $n = 0,1,2,3,\ldots$ ...

$\Delta L = m\lambda$

$\Delta L = \left(m + \frac{1}{2}\right)\lambda$

$f_n = \frac{nv}{2L}$, $n = 1,2,3,\ldots$

$f_n = \frac{nv}{4L}$, $n = 1,3,5,\ldots$

$y = 2y_m \sin(kx)\cos(\omega t)$

$\alpha = \frac{\Delta L}{L}\frac{1}{\Delta T}$, $PV = nRT = NkT$

$n = \frac{m}{M} = \frac{N}{N_A}$, $\beta = \frac{1}{V}\frac{\Delta V}{\Delta T}$

$Q = mL$, $W = \int P dV$,

$P = \frac{2}{3}\frac{N}{V}\left(\frac{1}{2}m\vec{v}^2\right)$, $C_p - C_v = R$

$Q = m c \Delta T$,

$\Delta E_{int} = Q - W$, $\Delta E_{int} = n c_v \Delta T$

$Q = n c_p \Delta T$, $Q = n c_v \Delta T$

$P V^\gamma = \text{constant}$, $T V^{\gamma-1} = \text{constant}$

$T_F = \frac{9}{5}T_c + 32$, $T_K = T_c + 273$

$W = Q_H - Q_L$, $\varepsilon = \frac{W}{Q_H} = 1 - \frac{Q_L}{Q_H}$

$\frac{Q_L}{Q_H} = \frac{T_L}{T_H}$, $K = \frac{Q_L}{W}$, $\Delta S = \int \frac{dQ_r}{T}$

$F = \frac{kq_1q_2}{r^2}$, $F = q_0 E$

$\varphi = \int_{\text{Surface}} \vec{E}\cdot d\vec{A}$, $E = \frac{kq}{r^2}$

$E = \frac{kQ}{R^3}r$, $E = \frac{2k\lambda}{r}$

$\varphi_c = \oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$

$E = \frac{\sigma}{2\varepsilon_o}$, $E = \frac{\sigma}{\varepsilon_o}$, $V = \frac{kQ}{r}$,

$\Delta S = nR\ln\frac{V_f}{V_i} + nC_v \ln\frac{T_f}{T_i}$

$\Delta V = V_B - V_A = -\int_A^B \vec{E}\cdot d\vec{S} = \frac{\Delta U}{q_0}$,

$E_x = -\frac{\partial V}{\partial x}$, $E_y = -\frac{\partial V}{\partial y}$, $E_z = -\frac{\partial V}{\partial z}$

$U = \frac{kq_1q_2}{r_{12}}$, $C = \frac{Q}{V}$, $C_o = \frac{\varepsilon_0 A}{d}$

$C = 4\pi\varepsilon_o \frac{ab}{b-a}$, $U = \frac{1}{2}CV^2$

$u = \frac{1}{2}\varepsilon_o E^2$, $C = \kappa C_0$,

$E = \frac{E_0}{\kappa}$, $V = \frac{V_o}{\kappa}$, $I = \frac{dQ}{dt}$,

$q(t) = q_o e^{-t/RC}$

$\tau = N i A B \sin\theta$

$\vec{F} = q(\vec{v}\times\vec{B})$, $\vec{F} = i(\vec{L}\times\vec{B})$

$F_{ba} = \frac{\mu_o L i_a i_b}{2\pi d}$, $d\vec{B} = \frac{\mu_0}{4\pi}\frac{i\, d\vec{s}\times\vec{r}}{r^3}$,

$\oint \vec{B}\cdot d\vec{s} = \mu_0 i_{enc}$

$B = \frac{\mu_0 i}{4\pi R}\varphi$, $B = \frac{\mu_0 i}{2\pi r}$,

$B_s = \mu_0 n i$, $\varphi_B = \int_{\text{Surface}} \vec{B}\cdot d\vec{A}$

$\varepsilon = -\frac{d\varphi_B}{dt}$, $\varepsilon = BLv$

$v = v_o + at$

$x - x_o = v_o t + \frac{1}{2}at^2$

$v^2 = v_o^2 + 2a(x - x_o)$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N.m^2$

$k = 9.0 \times 10^9\ N.m^2/C^2$

$q_e = -1.6 \times 10^{-19}\ C$

$m_e = 9.11 \times 10^{-31}$ kg

$m_p = 1.67 \times 10^{-27}$ kg

$1\ eV = 1.6 \times 10^{-19}$ J

$\mu_0 = 4\pi \times 10^{-7}$ Wb/A. m

$k_B = 1.38 \times 10^{-23}$ J/K

$N_A = 6.02 \times 10^{23}$ molecues/mole

$1\ atm = 1.013 \times 10^5\ N/m^2$

R = 8.31 J/mol. K

$g = 9.8\ m/s^2$, 1 cal = 4.186 J,

for water:

$c = 4190 \frac{J}{kg.K}$

$L_F = 333 \frac{kJ}{kg}$, $L_V = 2256 \frac{kJ}{kg}$