विध्न विचारत भीरु जन, नहीं आरम्भे काम,
विपति देख छोड़े तुरंत मध्यम मन कर श्याम।
पुरुष सिंह संकल्प कर, सहते विपति अनेक,
'बना' न छोड़े ध्येय को, रघुबर राखे टेक।।

रचितः मानव धर्म प्रणेता
सद्गुरु श्री रणछोड़दासजी महाराज

HEAT AND THERMODYNAMICS

Some questions (Assertion–Reason type) are given below. Each question contains STATEMENT – 1 (Assertion) and STATEMENT – 2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct. So select the correct choice :

Choices are :

(A) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is** a correct explanation for Statement – 1.
(B) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is NOT** a correct explanation for Statement – 1.
(C) Statement – 1 is True, Statement – 2 is False.
(D) Statement – 1 is False, Statement – 2 is True.

319. **STATEMENT – 1**
Specific heat and latent heat are same.

STATEMENT – 2
At constant temperature PV = constant.

320. **STATEMENT – 1**
Conduction is the process by which heat is transferred fro one end to another end of metal rod.

STATEMENT – 2
In conduction the atoms vibrates to transfer heat from one end to another end of metal rod.

321. **STATEMENT – 1**
The work done by magnetic force on a charged particle moving in uniform magnetic field is zero.

STATEMENT – 2
Magnetic field always applies magnetic force which is always perpendicular to the velocity vector.

322. **STATEMENT – 1**
Absolute zero temperature is not the temperature of zero energy.

STATEMENT – 2
Only the translational kinetic energy of the molecules is represented by temperature.

323. **STATEMENT – 1**
An ideal gas has infinitely many molar specific heats.

STATEMENT – 2
Specific heat is amount of heat needed to raise the temperature of 1 mole of gas by 1 K.

324. **STATEMENT – 1**
Adiabatic expansion is always accompanied by fall in temperature.

STATEMENT – 2
In adiabatic process, volume is inversely proportional to temperature.

325. **STATEMENT – 1**
The bulb of one thermometer is spherical while that of the other is cylindrical. Both have equal amount of mercury. The response of the cylindrical bulb thermometer will be quicker.

STATEMENT – 2
Heat conduction in a body is directly proportional to cross–sectional area.

326. **STATEMENT – 1**
The expanded length l of a rod of original length l_0 is not correctly given by (assuming α to be constant with T)
$l = l_0 (1 + \alpha \Delta T)$

if $\alpha \Delta T$ is large.

STATEMENT – 2
It is given by
$l = l_0 e^{\alpha\Delta T}$, which cannot be treated as being approximately equal to $l_0 (1 + \alpha \Delta T)$ for large value $\alpha \Delta T$.

327. **STATEMENT – 1**
A common model of a solid assumes the atoms to be points executing SHM about mean lattice positions. This model cannot explain thermal expansion of solids.

STATEMENT – 2
The average distance over a time period of oscillation between the particles remains constant.

328. **STATEMENT – 1**
In a free adiabatic expansion of an ideal gas the final state is the same as the initial state.

STATEMENT – 2
No work is done on the gas in a free expansion.

329. **STATEMENT – 1**
If temperature of a gas increases work done by it is positive.

STATEMENT – 2
As temperature of a gas increases its internal energy increases.

330. **STATEMENT – 1**
The specific heat of a gas in an adiabatic process is zero but it is infinite in an isothermal process.

STATEMENT – 2
Specific heat of a gas directly proportional to heat exchanged with the system and inversely proportional to change in temperature.

331. **STATEMENT – 1**
Work done by a gas in isothermal expansion is more than the work done by the gas in the same expansion adiabatically.

STATEMENT – 2
Temperature remains constant in isothermal expansion but not in adiabatic expansion.

332. **STATEMENT – 1**
Joule's effect is irreversible, but Peltier effect is reversible.

STATEMENT – 2
On reversing the direction of current, amount of heat produced remains same. But on reversing the direction of current through a thermocouple, heat is evolved at the junction when it was absorbed.

333. **STATEMENT – 1**
The steam at 100ºC causes more severe burn to human body than the water at 100ºC.

STATEMENT – 2
The steam has greater internal energy due to latent heat of vaporization.

334. **STATEMENT – 1**
The internal energy of a given sample of an ideal gas depends only its temperature according to kinetic theory of gases.

STATEMENT – 2
The ideal gas molecules do not exert intermolecular forces.

335. **STATEMENT – 1**
Two sphere of same material have radius r_1 and r_2 respectively and temperature 4000 K and 2000 K respectively. The energy radiated per second by 1st sphere must be more than second sphere.

STATEMENT – 2
Energy radiated by a body is given by Stefan's law as

$$\frac{dQ}{dt} = e\sigma AT^4 .$$

336. **STATEMENT – 1**
Density of humid air is less then density of dry air at the same temperature and pressure.

STATEMENT – 2
Mass of humid air is more than mass of dry air.

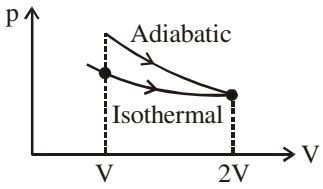
337. **STATEMENT – 1 :** Internal energy change is zero if the temp is constant, irrespective of the process being cyclic or non–cyclic.

STATEMENT – 2 : $dU = n C_v dT$ for all process and is independent of path.

338. **STATEMENT – 1 :** All process in which pressure and volume are proportional, take place at constant temp.

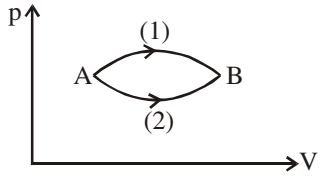
STATEMENT – 2 : Work done in a thermodynamical process is path dependent.

339. **STATEMENT – 1 :** A gas is expanded from a volume V to 2V, first through adiabatic process then through isothermal process. Work done in isothermal process is more if final stage (i.e. pressure and volume) in both case is same.



STATEMENT – 2 : Work done by gas is equal to area under p–V curve.

340. **STATEMENT – 1 :** A gas is taken from state A to state B through two different paths. Molar specific heat capacity in path (1) is more as compared to (2).



STATEMENT – 2 : $C = \dfrac{\Delta Q}{n\Delta T}$

$\Delta Q = \Delta U + W$
and W is equal to area under p–V diagram.

341. **STATEMENT – 1 :** In isothermal process whole of the heat energy supplied to the body is converted into internal energy.

STATEMENT – 2 : According to the first law of thermodynamics $\Delta Q = \Delta U + P\Delta V$

342. **STATEMENT – 1 :** A body that is a good radiator is also a good absorber of radiation at a given wavelength

STATEMENT – 2 : According to Kirchoff's Law the absorptivity of a body is equal to it's emissivity at a given wavelength.

343. **STATEMENT – 1 :** On sudden expansion a gas cools.

STATEMENT – 2 : On sudden expansion, no heat is supplied to system and hence gas does work at the expense of its internal energy.

344. **STATEMENT – 1 :** In thermal conduction, energy is transferred due to chaotic motion of conduction electron and atomic vibrations from region of high temperature to low temperature.

STATEMENT – 2 : There is overall transference of particles of conducting body.

345. **STATEMENT – 1 :** Two different gas molecules having same temperature will have the same KE.

STATEMENT – 2 : KE of gas molecules follows the Boltzmann's law.

346. **STATEMENT – 1 :** The specific heat of a monatomic gas has value between o and ∞.

STATEMENT – 2 : $c_P = \frac{5}{2}$ R and $c_V = \frac{3}{2}$ R . for a monoatomic gas.

347. **STATEMENT – 1 :** The specific heat of a gas in an adiabatic process is zero and in an isothermal process is infinite.

STATEMENT – 2 : Specific heat of a gas into directly proportional to change of heat in system and inversely proportional to change in temperature.

348. **STATEMENT – 1 :** Two stars S_1 and S_2 radiate maximum energy at 360 nm and 480 nm respectively. Ratio of their absolute temperatures is 4 : 3.

STATEMENT – 2 : According to Wien's law $\lambda T = b$ (constant)

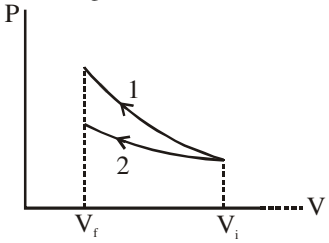
349. **STATEMENT – 1 :** In adiabatic process work done on the system is equal to negative of change in internal energy.

STATEMENT – 2 : In adiabatic process exchange of heat is zero.

350. **STATEMENT – 1 :** In cyclic process, initial and final state are same. Therefore net work done is zero.

STATEMENT – 2 : Initial and final temperature is equal therefore change in internal energy is zero.

351. **STATEMENT – 1 :** Work done in process 1 is greater than work done in process 2.



STATEMENT – 2 : Process 1 is isothermal and process 2 is adiabatic.

352. **STATEMENT – 1 :** In an adiabatic process, change in internal energy of a gas is equal to work done on or by the gas in the process.

STATEMENT – 2 : Temperature of gas remains constant in an adiabatic process.

353. **STATEMENT – 1 :** Greater is the coefficient of thermal conductivity of a material, smaller is the thermal resistance of a rod of that material.

STATEMENT – 2 : Thermal resistance is the ratio of temperature difference between the ends of the conductor and rate of flow of heat.

354. **STATEMENT – 1 :** The coefficient of volume expansion has dimension K^{-1}.

STATEMENT – 2 : The coefficient of volume expansion is defined as the change in volume per unit volume per unit change in temperature.

355. **STATEMENT – 1 :** In an adiabatic process, change in internal energy of a gas is equal to work done on or by the gas in the process.

STATEMENT – 2 : Temperature of gas remains constant in a adiabatic process.

Hint & Solution

319. (D) 320. (A)
321. (A) 322. (A) 323. (B) 324. (C)

325.	(A)	326.	(A)	327.	(A)	328.	(D)
329.	(D)	330.	(A)	331.	(B)	332.	(A)
333.	(A)	334.	(A)	335.	(D)	336.	(C)
337.	(A)	338.	(D)	339.	(C)	340.	(A)
341.	(D)	342.	(A)	343.	(A)	344.	(C)
345.	(A)	346.	(B)	347.	(A)	348.	(A)
349.	(A)	350.	(D)	351.	(C)	352.	(C)
353.	(B)	354.	(A)	355.	(C)		

325. Both are true and statement 2 explains statement 1 because for same volume, surface are of the cylindrical bulb will be more.

326. $$\alpha = \frac{1}{\ell}\frac{d\ell}{dT}$$

$$\Rightarrow \quad \alpha\int_{T_0}^{T} dT = \int_{\ell_0}^{\ell}\frac{d\ell}{\ell}$$

$$\Rightarrow \quad \ell = \ell_0 e^{\alpha\Delta T}.$$

327. The correct model is one in which the atoms fling away from the equilibrium position through a greater distance than the one by which they come closer.

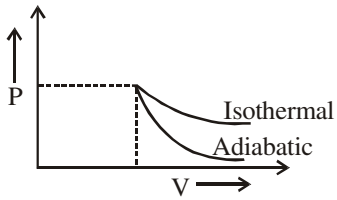
328. Although the temperature of the gas remains constant, volume and pressure at the end of the process are different from initial values.

330. $$C = \frac{\Delta\theta}{M\Delta T}$$

In adiabatic process, $\Delta\theta = 0$

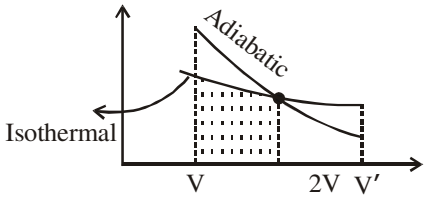
In isothermal process, $\Delta T = 0$.

331.



The slop of adiabatic curve is 7 times. The slope of an isothermal curve. As 7 > 1, area under adiabatic curve is smaller than that under isothermal curve.

339. When final stage is same with same initial volume the work done in adiabatic expansion is more.

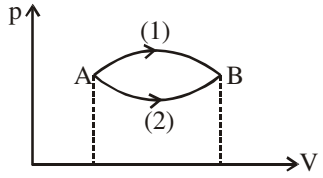


340. $\Delta Q = \Delta U + W$

W = area under the curve

As work in path (1) > work in path (2) so ΔQ is more for path (1)

$\Rightarrow \quad C_1 > C_2$.



341. As there is no change in internal energy of the system during an isothermal change. Hence the energy taken by the gas is utilized by doing work against external pressure.

342. According to Kirchoff's Law $\frac{e_\lambda}{a_\lambda} = E_\lambda$

It for a particular wavelength $E_\lambda = 1 \Rightarrow e_\lambda = a_\lambda$

$\therefore$ emissivity = absorptivity

343. When internal energy is utilized in expansion, the temperature falls.

344. There is only energy transfer and not matter transfer.

345. $E = \frac{3}{2}KT$. (Boltz mann's law)

346. The specific heat of a gas is always process dependent; and $C = \left(\frac{\Delta Q}{\Delta T}\right)$.

347. $c = \frac{Q}{m.\Delta T}$ a gas be heated by pulling pressure, so it can have values for O to ∞ in adiabatic process c = 0 and in isothermal process c = ∞.

348. On comparison

$$\frac{T_1}{T_2} = \frac{\lambda_2}{\lambda_1} = \frac{480}{360} = \frac{4}{3}$$

349. If $\Delta Q = 0$ then only $\Delta U = -\Delta\omega$.

350. For cyclic process $\Delta U = 0$

$\Delta Q = \Delta\omega$.

351. Slope of graph 1 > slope of graph 2.
So, 1 may be adiabatic and 2 isothermal or both adiabatic.

352. In an adiabatic process, no exchange of heat
i.e., $\Delta Q = 0$
$\Delta Q = \Delta U + \Delta W = 0$
$\Rightarrow$ $\Delta U = -\Delta W$.

353. $R = \frac{(\theta_1 - \theta_2)}{\omega / t} = \frac{\ell}{KA} \Rightarrow R \propto \frac{1}{K}$.

354. As $r = \frac{\Delta V}{V\Delta t}$ i.e., unit of coefficient of volume expansion is K^{-1}.

355. In an adiabatic process, no exchange of heat is permissible i.e., $d\theta = 0$
As $d\theta = dU + dw = 0$
$\therefore$ $dU = -dw$