ECAT Physics Chapter 11 Heat & Thermodynamics Online Test

Sr	Questions	Answers Choice
1	The behaviour of gases is well accounted by the kinetic theory based on	A. microscopic approach B. macroscopic approach C. both of them D. none of them
2	Which of the following is not an assumption of kinetic energy	A. a finite volume of gas consists of very large number of molecules B. the gas molecules are in random motion C. collision between the gas molecules are inelastic D. the size of the gas molecules is much smaller than the separation between molecules
3	If N is the total number of molecules and V is the volume of the container, then the expression for the pressure of gas is	A. P=P/V<1/2mv²> B. P=2N/V<1/2mv²> C. P=2/3N/V<1/2mv²> D. P=2/3N/V<mv²>
4	The pressure of gas everywhere inside the vessel will be the same provided the gas is of	A. Non-uniform density B. uniform density C. high density D. low density
5	While deriving the equation for pressure of a gas we consider the	A. rotational motion of molecules B. vibrational motion of molecules C. linear motion of molecules D. all of them
6	The pressure exerted by the gas is	A. directly proportional to the P.E B. inversely proportional to the P.E C. inversely proportional to the K.E D. directly proportional to the K.E
7	The ideal gas law is	A. P = nRT B. V = nRT C. PV =RT D. PV =nRT
8	The Boltzman constant has the value	A. 1.38 x 10⁻²³JK⁻¹ B. 1.28 x 10⁻²³JK⁻¹ C. 1.38 x 10⁻²⁶JK⁻¹ D. 1.28 x 10⁻²⁶JK⁻¹
9	The absolute temperature for an ideal gas is	A. directly proportional to the rotational K.E of gas molecules B. directly proportional to the vibrational K.E of gas molecules C. directly proportional to the average translational K.E.of gas molecules D. directly proportional to the P.E. of gas molecules
10	The volume of given mass of a gas will be doubled at atmosphere pressure if the temperature of the gas is changed from 150°C to	A. 300°C B. 573°C C. 600°C D. 743°C
11	Internal energy is the sum of all the forms of	A. K.E B. P.E C. both of them D. none of them

12	In the study of thermodynamics, which gas is considered as the working substance	A. real gas B. ideal gas C. any gas may be ideal or real D. none of them
13	The internal energy of an ideal gas system is generally the	A. translational K.E of molecules B. vibrational K.E of molecules C. rotational K.E of molecules D. all of them
14	When two objects are rubbed together, their internal energy	A. remains same B. decreases C. remains the same then decreases D. increases
15	In thermodynamics, internal energy is the function of	A. temperature B. pressure C. state D. none of them
16	The internal energy of a system does not depend upon the	A. initial state of the system B. final state of the system C. path D. none of them
17	The work done by the system on its environment is considered as	A. positive B. negative C. zero D. any one of them
18	The work done on the system by the environment is considered as	A. positive B. negative C. zero D. any one of them
19	If an amount of heat enters the system it could	A. decrease the internal energy B. not change the internal energy C. increase the internal energy D. none of them
20	We can express the work in term of	A. directly measurable variables B. indirectly measurable variables C. either of them D. both of them
21	A diatomic gas molecule has	A. translational energy B. rotaional energy C. vibrational energy D. all of them
22	The bicycle pump provides a good example of	A. first law of thermodynamics B. second law of thermodynamics C. third law of thermodynamics D. none of them
23	If 42 J heat is transferred to the system and the work done by the system is 32 J then what will be the change in internal energy	A. 0 J B. 2 J C. 5 J D. 10 J
24	The process which is carried out at constant temperature is known as	A. adiabatic process B. isothermal process C. isochoric process D. none of them
25	In which process the condition for the application of Boyle's law on the gas is fulfilled	A. isochoric process B. adiabatic process C. isothermal process D. none of them
26	In case of an ideal gas, the P.E associated with its molecule is	A. maximum B. zero C. minimum D. not fixed
27	The curve representing an isothermal process is called	A. adiabat B. isotherm C. fixed temperature D. none of them
28	A process in which no heat enters or leaves the system is called	A. isochoric process B. isothermal process C. adiabatic process D. none of them
29	In an adiabatic process the work is done at the expense of the	A. energy supplied to the system B. energy gained from the surroundings C. internal energy D. none of them

		D. none of them
30	In an adiabatic expansion, the temperature of the gas	A. increases B. becomes zero C. decreases D. decreases rapidly
31	Adiabatic change occurs when the gas	A. expands B. compressed C. expands or compressed D. expands or compressed rapidly
32	Which of the following is not an example of adiabatic process	A. the rapid escape of air from a burst type B. the rapid expansion and compression of air through which a sound wave is passing C. cloud formation in the atmosphere D. none of them
33	The curve representing an adiabatic process is called	A. isotherm B. adiabat C. adiable D. none of them
34	One kilogram of different substances contain	A. same number of molecules B. different number of molecules C. may be same or different D. none of them
35	One mole of any substance contain	A. same number of molecules B. different number of molecules C. may be same or different D. none of them
36	The heat required to raise the temperature of one mole of the substance through 1 K is called	A. heat capacity B. specific heat capacity C. molar specific heat D. all of them
37	The heat required to raise the temperature of one mole of the gas through 1 K at constant volume is called	A. heat capacity B. specific heat capacity C. molar specific heat D. molar specific heat at constant volume
38	Heat required to raise the temperature of one mole of a gas through 1 K at constant pressure is called	A. heat capacity B. specific heat capacity C. specific heat at constant volume D. specific heat at constant pressure
39	A process which can be retraced in exactly reverse order, without producing any change in the surroundings is called	A. reversible process B. irreversible process C. any one of them D. none of them
40	In the reverse process, the working substance passes through the same stages as in the direct process and	A. thermal effects at each stage are exactly reversed B. mechanical effects at each stage are exactly reversed C. thermal and mechanical effects at each stage remain the same D. thermal and mechanical effects at each stage are exactly reversed
41	A succession of events which bring the system back to its initial condition is called	A. reversible process B. irreversible process C. a cycle D. none of them
42	A reversible cycle is the one in which	A. some of the changes are reversible B. all of the changes are reversible C. all of the changes are irreversible D. none of them
43	If a process cannot be retraced in the backward direction by reversing the controlling factors, it is	A. a reversible process B. an irreversible process C. any one of them D. both of them
44	The example of reversible process is	A. an explosion B. changes occur suddenly C. slow compression of a gas D. all of them
45	The example of irreversible process is	A. slowly liquification B. slowly evaporation C. an explosion D. all of them
		A. mechanical energy into thermal energy B. thermal energy into mechanical energy

46	A heat engine is that which converts	C. K.E into potential energy D. heat energy into light energy
47	The earliest heat engine was	A. petrol engine B. diesel engine C. electric engine D. steam engine
48	In a heat engine, heat is supplied by the	A. cold reservoir B. sink C. hot reservoir D. none of them
49	First law of thermodynamics tells us that heat energy can be converted into equivalent amount of work, but it is silent about	A. how heat is absorbed B. how heat extracted C. how this conversion takes place D. none of them
50	The second law of thermodynamics is concerned with the circumstances in which	A. heat can be converted into work B. direction of flow of heat C. none of them D. both of them
51	The percentage of available heat energy converted into work by a petrol engine is roughly	A. 35 % B. 40 % C. 35 to 40 % D. 25 %
52	The percentage of available heat energy converted into work by a diesel engine is roughly	A. 35 %` B. 40 % C. 35 - 40 % D. 25 %
53	It is impossible to devise a processes which may convert heat, extracted from a single reservoir, entirely into work without leaving any change in the working system. This is the statement of	A. Clausius statement of second law B. Kelvin'sstatement of second law C. Clausius statement of first law D. Kelvin's statement of first law
54	According to the second law, which is must to produce work	A. a source contains a large amount of heat energy B. two sources at the same temperature C. two sources at the different temperatures D. a source contains a small amount of energy
55	For the working of a heat engine, there must be	A. a source of heat at high temperature B. a sink at low temperature C. both of them D. none of them
56	We cannot utilize the heat contents of oceans and atmosphere because	A. there is no reservoir at the same temperature B. there is no reservoir at the temperature lower than any one of two C. there is no reservoir at the temperature higher than any one of two D. none of them
57	Sadi carnot described an ideal heat engine in	A. 1820 B. 1840 C. 1860 D. 1880
58	Carnot heat engine only used	A. isothermal processes B. adiabatic processes C. both of them D. none of them
59	A carnot cycle consists of	A. One step B. two step C. three steps D. four steps
60	During the whole carnot cycle	A. Thermal equilibrium is maintained B. mechanical equilibrium is maintained C. both the thermal and mechanical equilibriumis maintained D. both the thermal and mechanical equilibrium is not maintained
61	When the temperature of source and sink of a heat engine become equal entropy change will be	A. Zero B. Max C. Min D. -ve
62	The highest efficiency of a heat engine whose low temperature is 17°C and the high temperature is 200°C is	A. 70% B. 100% C. 35%

	temperature is 200 C is	C. 35% D. 38%
63	Efficiency of carnot engine is independent of the	A. temperature of sink B. temperature of source C. nature of the working substances D. none of them
64	The efficiency of carnot engine cannot be 100% or one unless cold reservoir is at	A. 100 K B. 273 K C. 0 K D. -273 K
65	Generally a temperature scale is established by	A. one fixed point B. two fixed point C. three fixed point D. four fixed point
66	Generally a temperature scale is established by using certain physical properties of a material which varies	A. nonlinearly with temperature B. linearly with temperature C. either of them D. none of them
67	The basis to define a temperature scale that is independent of material properties is provided by	A. carbon cycle B. nitrogen cycle C. Carnot cycle D. irreversible cycle
68	The absolute temperature of the tripple point of water is	A. 100°C B. 4°C C. 373 K D. 273.16 K
69	The unit of thermodynamical scale is	A. centigrade B. fahrenheit C. kelvin D. none of them
70	The state in which ice, water and vapour coexists in equilibrium is called	A. zero degree celsius B. zero degree fahrenheit C. absolute zero D. 373 K
71	Since the absolute scale is independent of the property of the working substance, hence, can be applied at	A. very high temperature B. very low temperature C. any one of them D. none of them
72	A typical four stroke petrol engine undergoes how many successive processes in each cycle	A. one B. two C. three D. four
73	On the compression stroke of the petrol engine, the inlet value is closed and the mixture is compressed	A. adiabatically B. isothermally C. isochorcally D. isobarically
74	On the power stroke, a spark fires the mixtures causing a rapid increase in pressure and temperature and the burning mixture expands	A. adiabatically B. isothermally C. isochorically D. isobarically
75	On the exaust stroke, the outlet values opens. The residual gases are expelled and piston moves	A. outwards B. inwards C. in either way D. none of these
76	The efficiency of petrol engine is usually not more than 25% to 30% because of	A. friction B. heat losses C. both of them D. none of them
77	No spark plug is needed in	A. petrol engine B. diesel engine C. both of them D. none of them
78	The efficiency of diesel engine is	A. 25% B. 25 - 30% C. 35% D. 35 - 40%
79	The concept of entropy was introduced into the study of thermodynamics in	A. 1856 B. 1865

	The concept of entropy was introduced into the study of thermodynamics in	C. 1656 D. 1685
80	Which of the following is a state variable	A. entropy B. pressure C. volume D. all of them
81	Which quantity is important in stating the entropy of the system	A. initial entropy B. final entropy C. change in entropy D. none of them
82	When heat is added into the system then change in entropy is	A. negative B. positive C. zero D. any one of them
83	When heat is removed from the system	A. negative B. positive C. zero D. any one of them
84	In all natural processes where heat flows from one system to another, there is always a net	A. decrease in entropy B. increase in entropy C. decrease or increase in entropy D. none of them
85	If a system undergoes a natural process it will go in the direction that causes the entropy of the system plus the environment to increase, this is another statement of	A. second law thermodynamics B. first law of thermodynamics C. third law of thermodynamics D. none of them
86	An irreversible heat flow from a hot to cold substances of a system, causes the disorder to	A. decrease B. remains the same C. increase D. any one of them
87	The disorder in the system increases due to the	A. removal of heat B. addition of heat C. removal or addition of heat D. none of them
88	A process is a reversible process, if the entropy of the system	A. increases B. decreases C. remains constant D. none of them
89	The number of translation degress of freedom for a diatomic gas is	A. 2 B. 3 C. 5 D. 6
90	At constant volume temperature is increased. Then	A. Collision on walls will be less B. Number of collisions per unit time will increase C. Collision will be in straight lines D. Collision will not change
91	Which of the following is not thermo dynamical function?	A. Enthalpy B. Work done C. Gibb's energy D. Internal energy
92	Absolute temperature can be calculated by	A. Means squares velocity B. Motion of the molecule C. Both A and B D. None of these
93	Boyle's law is applicable in	A. Isochoric process B. Isothermal process C. Isobaric process D. Isotonic process
94	The product of the pressure and volume of an ideal gas is	A. A constant B. Approximately equal to the universal gas constant C. Directly proportional to its temperature D. Inversely proportional to its temperature
95	At O° K which of the following properties of a gas will be zero?	A. Kinetic energy B. Potential energy C. Vibrational energy D. Density
		A. 32°F B. 39.2<span style="color: rgb(84, 84, 84);

96	Maximum density of H_2O is at the temperature	font-family: arial, sans-serif; font-size: small;">°F C. 42°F D. 4°F
97	R.M.S velocity of a particle is V at pressure P. If pressure increases by two times, then R.M.S velocity becomes	A. 2V B. 3V C. 0.5V D. V
98	Energy gas behaves like an ideal gast at	A. High temperature and low pressure B. Low temperature and high pressure C. Both A and B D. None
99	The volume of a gas will be double of what it is at 0°C (pressure remaining constant) at	A. 546 K B. 273 K C. 546°C D. 273°C
100	If the ratio of densities of two gases is 1:4, then the ratio of their rates of diffusion into one another is	A. 2 : 1 B. 4 : 1 C. 1 : 4 D. 3 : 4
101	Brownian motion increases due to	A. Increase in size of Brownian particle B. Increase in temperature of medium C. Increase in density of medium D. Increase in viscosity of medium
102	An isochoric process is one which take place at	A. Constant internal energy B. Constant entropy C. Constant volume D. Constant pressure
103	10 c.c. each of oxygen and hydrogen are kept in separate flasks. Then which of the following relations is correct?	A. Each have same number of molecules B. Don't have same number of molecules C. Can't be predicted D. None
104	According to kinetic theory of gases, molecules of a gas behave like	A. Inelastic spheres B. Perfectly elastic rigid sphere C. Perfectly elastic non-rigid spheres D. Inelastic non-rigid spheres
105	Pressure of a gas at constant volume is proportion to	A. Total energy of gas B. Average P.E to molecules C. Average K.E of molecules D. Total internal energy of gas
106	Rate of diffusion is	A. Faster in solids than in liquids and gases B. Faster in liquids than in solids and gases C. Equal to solids, liquids and gases D. Faster in gases than in liquids and solids
107	Triple point of water is	A. 273.16°F B. 372.16K C. 273.16°F D. 273.16
108	If R is gas constant for 1 gram mole, $C_p$and $C_v$are specific heat for a solid then	A. C_p- C_v= R B. C_p- C_{v < R} C. C_p- C_{v = 0} D. C_p- C_{v > R}
109	A real gas can be approximated to an ideal gas at	A. Low density B. High pressure C. High density D. Low temperature
110	If the volume of the gas is to be increased by 4 times, then	A. Temperature and pressure must be doubled B. At constant P the temperature must be increased by 4 times

110	If the volume of the gas is to be increased by 4 times, then	increased by 4 times C. At constant T the pressure must be increased by four times D. It cannot be increased
111	The temperature of gas is produced by	A. At potential energy of its molecules B. The kinetic energy of its molecules C. The attractive force between its molecules D. The repulsive force between its molecules
112	Pressure exerted by a gas is	A. Independent of density of the gas B. Inversely proportional to the density of the gas C. Directly proportional to the square of the density of the gas D. Directly proportional to the density of the gas
113	At absolute temperature, the kinetic energy of the molecules	A. Becomes zero B. Becomes maximum C. Becomes minimum D. Remain constant
114	On colliding in a closed container, the gas molecules	A. Transfer momentum to the walls B. Momentum becomes zero C. Move in opposite directions D. Perform Brownian motion
115	At constant temperature, on increasing the pressure of a gas by 5%, its volume. The final temperature of the gas will be	A. 81 K B. 355 K C. 627 K D. 627°C
116	The kinetic energy of one molecule of a gas at normal temperature and pressure will be (k = 8.31 J/mole K) :	A. 1.7 x 10³J B. 10.2 x 10³J C. 3..4 x 10³J D. 6.8 x 10³J
117	Hydrogen and helium of same volume V at same temperature T and same pressure P are mixed to have same volume V. The resulting pressure of the mixtures will be	A. R/2 B. P C. 2P D. Depending on the relative mass of the gases
118	The length of a metallic rod is 5 meter at 100°C. The coefficient of cubical expansion of the metal will be	A. 2.0 x 10⁻⁵/°C B. 4.0x10⁻⁵/°C C. 6.0x10⁻⁵/°C D. 2.33x10⁻⁵/°C
119	Two metal rods A and B have their initial lengths in the ratio 2 : 3 and coefficients of linear expansion in the ratio 4 : 3. When they are heated through same temperature difference the ratio of their linear expansion is	A. 1 : 2 B. 2 : 3 C. 3 : 4 D. 8 : 9
120	The coefficient of linear expansion of iron is 0.000011 per°K. An iron rod is 10 metre long at 27°C. The length of the rod will be decreased by 1.1 mm when the temperature of the rod changes to	A. 0°C B. 10°C C. 17°C D. 20°C
121	If a liquid is heated in weightlessness, the heat is transmitted through	A. Conduction B. Convection C. Radiation D. Neither, because the liquid cannot be heated in weightlessness

122	For making cooking utensils, which of the following pairs of properties is most suited?	A. Low specific heat and high conductivity B. Low specific heat and low conductivity C. High specific heat and high conductivity D. High specific heat and low conductivity
123	Heat travels through vacuum by	A. Conduction B. Convection C. Radiation D. Both A and B
124	On a cold morning a metal surface will fell colder to touch than a wooden surface, because	A. Metal has high specific heat B. Metal has high thermal conductivity C. Metal has low specific heat D. Metal has low thermal conductivity
125	Good absorbers of heat are	A. Poor emitters B. Non emitters C. Good emitters D. Highly polarized
126	Amount of heat required to raise the temperature of a body through 1 K is called its	A. Specific heat B. Water equivalent C. Thermal capacity D. Entropy
127	What temperature is the same on Celsius scale as well as on Fahrenheit scale?	A. 32°C B. -32°C C. -40°C D. -212°C
128	If water in a closed bottle is taken up to the moon and opened, the water gets	A. Freeze B. Boiled C. Dissociated into O₂and H₂ D. Evaporated
129	Specific heat at constant pressure is greater than the specific heat at constant volume because	A. Heat is used up to increase temperature at constant pressure B. Heat is used by gas for expansions purposes at constant pressure C. Heat is use dup to increase internal energy D. The above statement is invalid
130	An amount of water of mass 20 g at 0°C is mixed with 40 g of water at 10°C. Final temperature of mixture is	A. -20°C B. 6.67°C C. 5°C D. 0°C
131	Melting point of ice	A. Increases with increasing pressure B. Decreases with increasing pressure C. Is independent of pressure D. Is proportional to pressure
132	Rice takes longest to cook	A. In a submarine 100 m below the surface of the sea B. At sea level C. At Murree D. At Mount Everest
133	Two samples A and B of a gas initially of the same temperature and pressure are compressed from a volume V to a volume V/2 such that A is compressed isothermally and B adiabatically. The final pressure	A. A greater than than of B B. A is equal to that of B C. A is less than that of B D. A is twice the pressure of B
134	First law of thermodynamic is special case of	A. Law of conservation of energy B. Charle's law C. Law of conservation of mass D. Boyle's law
135	At what temperature the adiabatic change is equivalent to the isothermal change?	A. Zero degree Celsius B. Zero Kelvin C. Critical temperature

		C. Critical temperature D. Above critical temperature
136	First law of thermodynamics is consequence of conservation of	A. Work B. Energy C. Heat D. All of these
137	A gas is compressed adiabatically till its temperature is double. The ratio of its final volume to initial volume will be	A. 1/2 B. More than 1/2 C. Less than 1/2 D. Between 1 and 2
138	Hotness and coldness of an object is represented in terms:	A. Heat B. Temperature C. Chemical energy D. None of these
139	Absolute zero is considered as that temperature at which:	A. All liquid become gases B. All gases become liquid C. Water freezes D. None of these
140	When two objects come to common temperature, the body is said to be in:	A. Static equilibrium B. Dynamic equilibrium C. Thermal equilibrium D. None of these
141	A gas which strictly obeys the gas laws under all conditions of temperature and pressure is called:	A. Ideal gas B. Inert gas C. Real gas D. None of these
142	Real gases strictly obey gas law at:	A. High pressure and low temperatures B. Low pressures and high temperatures C. High pressures and high temperatures D. None of these
143	At the constant temperature, if the value of a given mass of a gas is double, then the density of gas becomes:	A. Double B. Remains constant C. Half D. None of these
144	The only significant motion possessed by the mono-atomic gas represented is:	A. Translatory B. Rotatory C. Vibratory D. None of these
145	In the theory of dimensional analysis, heat may be properly represented by:	A. ML²T⁻² B. MT⁻² C. ML⁻¹T⁻¹ D. None of these
146	The temperature scale approved in SI units is:	A. Celsius scale B. Kelvin scale C. Fehrenheit scale D. None of these
147	Which of the following does not have the same units:	A. Work B. Heat C. Kinetic energy D. Power
148	In an ideal gas, the molecules have:	A. Kinetic energy only B. Potential energy only C. Both KE and PE D. None of these
149	The motion of molecules in gases is:	A. Orderly B. Random C. Circular D. All of these
150	At constant temperature, if the density of the gas is increased, its pressure will:	A. One kg of a substance B. Unit volume of a substance C. One mole of a substance D. None of these
151	The relationship between Boltzmann constant k with R and N_A is given as:	A. k = RN_A B. k =R/N_A C. k = NR/N_A D. None of these
152	The nature of thermal radiation is similar to:	A. Ultraviolet rays B. Light rays C. Both of them D. None of these
		A. Photoelectrons

153	Electromagnetic waves emitted by hot bodies are called:	A. Photoelectrons B. Alpha rays C. Thermal radiation D. None of these
154	Truth of kinetic energy is confirmed by:	A. Diffusion of gases B. Brownian motion C. Both A and B D. None of these
155	Pressure may be define as _____ per second per unit area:	A. Change in force B. Change in momentum C. Change in energy D. Work done
156	If a molecule with momentum mv strikes a wall and rebound then the change in momentum will be:	A. -2 mv B. Zero C. 2 mv D. mv
157	The rate of change of momentum of a molecule is equal to:	A. Pressure B. Work C. Density D. Force
158	If denotes the total number of molecules in cubic vessel such that m is mass of each milecule and l is length of each side of vessel, then mN/l^3gives the:	A. Force B. Density C. Work done D. Pressure
159	Pressure applied at any point of gas at rest is transmitted equally to all parts of the gas. This is the statement of:	A. Newton's second law B. Pascal's law C. Carnot theorem D. Second law of thermodynamics
160	While deriving equation of pressure by kinetic theory of gases, we take into account:	A. Only linear motion of molecules B. Only rotational motion C. Only vibratory motion D. All of these
161	If the formula PV = nRT, n denotes:	A. Number of molecules per unit volume B. Number of moles C. Number of molecules D. None of these
162	The volume of universal gas constant R is:	A. 8.314 J/K mole K B. 8314 J/K mole K C. 8.314 J/mole K D. None of these
163	In the formula $P = N_0KT$, N_0denotes:	A. Number of molecules per unit per volume B. Number of moles C. Number of molecules D. None of these
164	Tick the correct pair when M denotes the molecular mass and other symbols carry usual meanings:	A. N = nN_Am = MN_A B. n = N N_A, M = mN_A C. M = N_A/N , N_A= m/n D. N = nN_A, M = mN_A
165	Gas constant per molecule is called:	A. Universal gas constant B. Stefen's constant C. Boltzmann constant D. Gravitation constant
166	Average KE of a gas molecule has:	A. Direct relation with absolute temperature and inverse relation with pressure B. Direction relation with both absolute temperature and pressure C. Inverse relation with both absolute temperature and pressure D. None of these
167	If the distance between two charges is doubled, the force between them will become:	A. Double B. Half C. Three times D. One fourth E. One third
		A. 9 x 10⁹Nm²C⁻² B. 8.85 x 10⁻¹²C²N<sup>-

168	The value of E_0 in coulomb's law is:	1</sup>m⁻² C. 8.85 x 10⁻¹²Nm²C⁻² D. 9 x 10⁹C²N⁻¹m⁻²