QUAID-I-AZAM UNIVERSITY, ISLAMABAD

M.PHIL ENTRY TEST PAPER (24RD JANUARY, 2012)

(B)

REGISTRATION NUMBER:_____ NIC NUMBER:_____

FULL NAME:_____ SIGNATURE:_____

## M.Phil. Physics Admission Test

QUAID-I-AZAM UNIVERSITY
(DEPARTMENT OF PHYSICS)

January 24, 2012

Time: 90 Minutes

| CANDIDATES NOT TO WRITE BELOW |
|---|
| NUMBER CORRECT = |
| NUMBER WRONG = |
| TOTAL MARKS = |

- Answer all 25 questions or as many as you can.
- Each question carries equal marks. Circle only the right answer. If you do not know the answer, do not circle any answer.
- Circling two choices will be considered as a wrong answer.
- Wrong answers will be negatively marked (- 0.2 marks per mistake).
- If you make a mistake, make your choice clear by writing out the correct answer in full or indicating it clearly. Marking two choices will be considered as a wrong answer.
- Any attempt to copy answers from another candidate will result in permanent disbarment from the university for all purposes.
- No books or calculators are allowed.

*CIRCLE THE CORRECT ANSWER*

| | | | | | |
|---|---|---|---|---|---|
| Q.1 | A | B | C | D | E |
| Q.2 | A | B | C | D | E |
| Q.3 | A | B | C | D | E |
| Q.4 | A | B | C | D | E |
| Q.5 | A | B | C | D | E |
| Q.6 | A | B | C | D | E |
| Q.7 | A | B | C | D | E |
| Q.8 | A | B | C | D | E |
| Q.9 | A | B | C | D | E |
| Q.10 | A | B | C | D | E |
| Q.11 | A | B | C | D | E |
| Q.12 | A | B | C | D | E |
| Q.13 | A | B | C | D | E |

| | | | | | |
|---|---|---|---|---|---|
| Q.14 | A | B | C | D | E |
| Q.15 | A | B | C | D | E |
| Q.16 | A | B | C | D | E |
| Q.17 | A | B | C | D | E |
| Q.18 | A | B | C | D | E |
| Q.19 | A | B | C | D | E |
| Q.20 | A | B | C | D | E |
| Q.21 | A | B | C | D | E |
| Q.22 | A | B | C | D | E |
| Q.23 | A | B | C | D | E |
| Q.24 | A | B | C | D | E |
| Q.25 | A | B | C | D | E |

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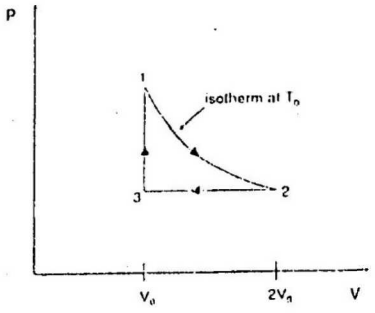
Q. 1 A block of material has a temperature-dependent heat capacity given by $C_V(T) = 5\ J/K + 2T\ (J/K^2)$. How much does the entropy of this object change as its temperature is increased from 10°C to 40°C at constant volume?

a) $60 + 5\ ln\ (1.10)$ J/K
b) $-60 + 5\ ln\ (1.10)$ J/K
c) $-60 + 5\ ln\ (1.10)$ J/K
d) $60 + 5T\ ln\ (1.10)$ J/K
e) 60 +5T J/K

Q. 2 Consider taking a monatomic ideal gas around the closed cycle depicted below. It consists of one isotherm at temperature $T_0$, one change at constant pressure (from $2V_0$ to $V_0$), and one change at constant volume. The heat capacity of the gas is $C_V = 3/2\ Nk$.

the work done by the gas after one cycle is




a) 0

b) $NkT_0 \ln 2 - \frac{NkT_0}{2}$

c) $-NkT_0 \ln 2 + \frac{NkT_0}{2}$

d) $NkT_0 \ln 2 + \frac{NkT_0}{2}$

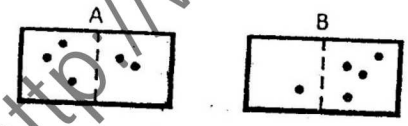
e) $-NkT_0 \ln 2 + \frac{NkT_0}{2}$

Q.3 A rubber ball with specific heat 150 $Jkg^{-1}K^{-1}$ is dropped from a height of 5m. After bouncing from a hard floor, it reaches a maximum height of 4.0 m. Assuming that all the energy lost in the collision goes into heating the ball, what is the change in temperature of the ball?

a. $\Delta T$ = 0.60 K
b. $\Delta T$ = 0.020 K
c. $\Delta T$ = 0.42 K
d. $\Delta T$ = 0.065 K
e. Not enough information is given

Q.4 A box contains five distinguishable particles in equilibrium. They are free to move between the left and right halves. Assuming that every microstate is equally likely, calculate the ratio, $P_A/P_B$, of the probabilities that five distinguishable particles will be in these two macrostates: A with three particles on the left and two on the right, and B with one on the left

Macrostate A: $N_L$= 3, $N_R$= 2.
Macrostate B: $N_L$= 1, $N_R$= 4.




a. $P_A/P_B$ = 24
b. $P_A/P_B$ = 1
c. $P_A/P_B$ = 5
d. $P_A/P_B$ = 2
e. $P_A/P_B$ = 10

B

Q. 5 A single particle system has 3 non-degenerate energy levels, $-\varepsilon$, 0 and $\varepsilon$. With $\beta \equiv 1/k_B T$ the average energy <E> is given by,

a. 0
b. $-\varepsilon$
c. $1+2\cosh\beta\varepsilon$
d. $1+2\sinh\beta\varepsilon$
e. $\dfrac{-2\sinh\beta\varepsilon}{1+2\cosh\beta\varepsilon}$

Q. 6 Evaluate the integral $\int_C [(x^2+2y)dx+(x+y^2)dy]$ from $A(0,1)$ to $B(2,3)$ along the curve $C$ defined by $y=x+1$.

A) 64/3
B) 0
C) 25/3
D) 67/8
E) 6

Q. 7 Find $\frac{dH}{dt}$ when $H(t) = \sin(3x - y)$ and $x = 2t^2 - 3, y = \frac{1}{2}t^2 - 5t + 1$.

A) $(11t + 5) + \cos\left(\frac{11}{2}t^2 + 5t - 10\right)$
B) $(11t + 5) + \sin\left(\frac{11}{2}t^2 + 5t - 10\right)$
C) $(11t - 5) + \sin\left(\frac{11}{2}t^2 + 5t - 10\right)$
D) $(11t + 5)\sin\left(\frac{11}{2}t^2 + 5t - 10\right)$
E) $(11t + 5)\cos\left(\frac{11}{2}t^2 + 5t - 10\right)$

Q. 8 Evaluate the contour integral $\oint_C \frac{e^z}{z-2} dz$ where $C$ is any contour enclosing $z = 2$ point.

A) $2\pi ie^2$
B) $2\pi e^3$
C) $-2\pi ie^2$
D) $4\pi ie^2$
E) 0

B

Q. 9 Evaluate $\lim_{x\to 0} \frac{1-\cos x}{x^2}$

A) $\frac{1}{2}$
B) 0
C) $\frac{1}{4}$
D) $2\pi$
E) 1

Q. 10 Find the curl of a vector $V = (2x - y^2)\hat{\imath} + (3z + x^2)\hat{\jmath} + (4y - z^2)\hat{k}$ At the point (1,2,3).

A) $\hat{\imath} + 6\hat{k}$
B) $6\hat{k}$
C) 0
D) $\hat{\imath}$
E) $\hat{\imath} - 6\hat{k}$

Q.11. When a certain rubber band is stretched a distance $x$, it exerts a restoring force of magnitude

$$F = ax + bx^2$$

Where $a$ and $b$ are constants. The work done in stretching this rubber band from $x = 0$ to $x = L$ is

A $aL^2 + bLx^3$
B $aL + 2bL^2$
C $a + 2bL$
D $bL$
E $\frac{aL^2}{2} + \frac{bL^3}{3}$

Q.12. A simple pendulum is suspended from the ceiling of an elevator. The elevator is accelerating upward with acceleration $a$. The time period of this pendulum in terms of its length $L$, $g$ and $a$ is

A $2\pi\sqrt{\frac{L}{g}}$
B $2\pi\sqrt{\frac{L}{g+a}}$
C $2\pi\sqrt{\frac{L}{g-a}}$
D $2\pi\sqrt{\frac{L}{a}}$
E $\frac{1}{2\pi}\sqrt{\frac{g}{L}}$

B

Q.13. An object is dropped from an altitude of one Earth radius above Earth's surface. If $M$ is the mass of Earth and $R$ is its radius, the speed of the object just before it hits Earth is given by

A $\sqrt{\frac{GM}{R}}$

B $\sqrt{\frac{GM}{2R}}$

C $\sqrt{\frac{2GM}{R}}$

D $\sqrt{\frac{GM}{R^2}}$

E $\sqrt{\frac{GM}{2R^2}}$

Q.14. A particle of mass m is constrained to move along a straight line and is attached toward a point on this line with a force proportional to $-x$ where $x$ is the distance from the point The Lagrangian function for this system is

A $L = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$

B $L = \frac{1}{2}mv^2 - \frac{1}{2}kx^2$

C $L = \frac{1}{2}mv^2 + kx$

D $L = \frac{1}{2}mv^2 - kx$

E $L = \frac{1}{2}mv^2 - kx^2$