



1. Choose the correct answer

(1)(4%) The inequality $a < b$ means $b - a$ is

- (A) positive (B) negative (C) zero (D) none

(2)(4%) The distance between the numbers a and b is the number

- (A) $a - b$ (B) $b - a$ (C) 0 (D) $|b - a|$

(3)(4%) The slope of the line tangent to the graph of the function f at the point $(x_0, f(x_0))$, if it exists, is the number

- (A) $\lim_{h \rightarrow 0} \frac{f(x_0 + h) - f(x_0)}{h}$ (B) $\lim_{h \rightarrow 0} \frac{f(x_0 + h) - f(h)}{h}$ (C) $\lim_{h \rightarrow 0} \frac{f(h + x_0) - f(x_0)}{x_0}$

- (D) $\lim_{x_0 \rightarrow 0} \frac{f(h + x_0) - f(x_0)}{x_0}$

(4)(6%) Assume that $\lim_{x \rightarrow a} f(x) = L$ exists, for any positive integer $n = 1, 2, \dots$

- (A) $\lim_{x \rightarrow a} [f(x)]^n = L$ (B) $\lim_{x \rightarrow a} [f(x)]^n = 0$ (C) $\lim_{x \rightarrow a} [f(x)]^n = 1$

- (D) $\lim_{x \rightarrow a} [f(x)]^n = L^n$.

(5)(6%) For the polynomial function

$$f(x) = x^4 - 4x^3 + 3x^2 - 5x + 3$$

- (A) $f'(x) = 4x^3 - 6x^2 + 12x - 5$ (B) $f''(x) = 12x^2 - 6x + 24$ (C) $f'''(x) = 24x - 6$

- (D) $f^{(4)}(x) = 24$.

(6)(8%) Let f be continuous on $[a, b]$ and suppose C is the only critical number of f in (a, b) . Then

- (A) if $f'(x) > 0$ for all $x \in (a, c)$ and if $f'(x) < 0$ for all $x \in (c, b)$, then $f(c)$ is a relative minimum.

- (B) if $f'(x) < 0$ for all $x \in (a, c)$ and if $f'(x) > 0$ for all $x \in (c, b)$, then $f(c)$ is a relative maximum.

- (C) if $f'(x) > 0$ for all $x \in (a, c) \cup (c, b)$, then f is increasing on $[a, b]$.

- (D) if $f'(x) > 0$ for all $x \in (a, c) \cap (c, b)$, then f is decreasing on $[a, b]$.



(7)(8%) Find a solution of the differential equation

$$\frac{dy}{dt} = 2 - ay, a \neq 0$$

- (A) $\ln|2 - ay| = -at - ac$, C arbitrary constant.
 (B) $\ln|ay| = -t - ac$, C arbitrary constant.
 (C) $\ln|2 - y| = -t - c$, C arbitrary constant.
 (D) $\ln|2a - y| = -at - c$, C arbitrary constant.

(8)(10%) The general solution of the differential equation

$$\frac{d^2y}{dt^2} - \frac{dy}{dt} - 2y = 0$$

- (A) $y = Ae^{-2t} + Be^t$ (B) $y = Ae^{2t} + Be^{-t}$ (C) $y = Ae^{2t} + Be^t$
 (D) $y = Ae^{-2t} + Be^{-t}$

2. (10%) Find the derivative of $f(x) = x^2 \sin x$.

3. (10%) Evaluate

$$\int_1^4 (x^{4/3} + 4x^{1/3}) dx$$

4. (10%) Find the absolute extrema of f on $[-2, 3]$ if

$$f(x) = 3x^3 - 6x - 1$$

5. (20%) Find the area of the region bounded by the curve $y = x^2 - 4x$, the x axis, and the lines $x = 1$ and $x = 3$.



共 8 題，每題 12.5 分。

1. 設隨機變數 X 之機率密度函數(PDF)為

$$f(x) = \begin{cases} ax^2 e^{-\frac{x}{2}}, & x \geq 0 \\ 0, & x < 0 \end{cases}, \text{ 試求 } a \text{ 值}$$

2. 一小型鋼琴的水平耐力為具下述機率密度函數(PDF)之隨機變數

$$f(x) = \begin{cases} \frac{3}{500}(x-10)(20-x), & 10 \leq x \leq 20 \\ 0, & x < 10, x > 20 \end{cases}, \text{ 求以下諸值:}$$

- (1) X 之平均值(mean)
- (2) X 之中間值(median)
- (3) X 之眾數(mode)
- (4) X 之標準值(standard deviation)
- (5) X 之變異係數(Coefficient of Variation)
- (6) X 之偏態係數(Coefficient of Skewness)

3. 試以動差法(Method of Moment) 證明指數分佈

$$f(x) = \lambda e^{-\lambda x} \text{ 之期望值為: } E(x) = \frac{1}{\lambda}; \text{ 變異數為: } Var(x) = \frac{1}{\lambda^2}$$

4. 某工廠下游某點 A 的每日溶氧濃度 DO 連續記錄 10 天結果如下:

日	1	2	3	4	5	6	7	8	9	10
DO(m ³ /L)	53.1	50.9	51.8	49.0	52.4	54.1	51.0	50.4	51.9	51.1

試求平均值 μ 之 95% 信賴區間?



5. A communication channel is being monitored by recording the number of errors in a string of 1000 bits. Data for 18 of these strings are given here.
- (Read data left to right, then down.)
- | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 1 | 0 | 1 | 3 | 2 | 4 | 1 | 3 | 1 |
| 1 | 1 | 2 | 3 | 3 | 2 | 0 | 2 | | |
- (a) Construct a stem-and-leaf plot of the data.
- (b) Find the sample average and sample standard deviation.
- (c) Construct a time series plot of the data. Is there evidence that there was an increase or decrease in the number of errors in a string? Explain.
6. Consider the 18 observations collected on the number of errors in a string of 1000 bits of a communication channel given in the above problem. Based on the description of the random variable and these 20 observations, is a Poisson distribution an appropriate model? Perform a goodness-of fit procedure with $\alpha=0.05$.
7. A random sample of $n = 16$ structural elements is tested for compressive strength. We know that the true mean compressive strength is $\mu = 5000$ psi and the standard deviation is $\sigma = 100$ psi. Find the probability that the sample mean compressive strength exceeds 4985 psi.
8. The thickness of a plastic film (in mils) on a substrate material is thought to be influenced by the temperature at which the coating is applied. A completely randomized experiment is carried out. Ten substrates are coated at 125°F , resulting in a sample mean coating thickness of $\bar{x}_1 = 103$ and a sample standard deviation of $s_1 = 10$. Another 15 substrates are coated at 150°F , for which $\bar{x}_2 = 100$ and $s_2 = 15$ are observed. It was originally suspected that raising the temperature would reduce mean coating thickness. Do the data support this claim? Use $\alpha = 0.01$ and assume that the two population standard deviations are not equal.



A-2 APPENDIX A STATISTICAL TABLES AND CHARTS

$$\Phi(z) = P(Z \leq z) = \int_{-\infty}^z \frac{1}{\sqrt{2\pi}} e^{-\frac{u^2}{2}} du$$

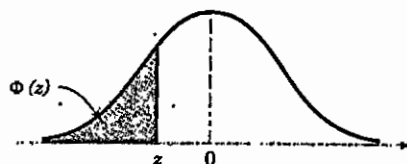


Table I Cumulative Standard Normal Distribution

	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00
-3.9	0.000033	0.000034	0.000036	0.000037	0.000039	0.000041	0.000042	0.000044	0.000046	0.000048
-3.8	0.000050	0.000052	0.000054	0.000057	0.000059	0.000062	0.000064	0.000067	0.000069	0.000072
-3.7	0.000075	0.000078	0.000082	0.000085	0.000088	0.000092	0.000096	0.000100	0.000104	0.000108
-3.6	0.000112	0.000117	0.000121	0.000126	0.000131	0.000136	0.000142	0.000147	0.000153	0.000159
-3.5	0.000165	0.000172	0.000179	0.000185	0.000193	0.000200	0.000208	0.000216	0.000224	0.000233
-3.4	0.000242	0.000251	0.000260	0.000270	0.000280	0.000291	0.000302	0.000313	0.000325	0.000337
-3.3	0.000350	0.000362	0.000376	0.000390	0.000404	0.000419	0.000434	0.000450	0.000467	0.000483
-3.2	0.000501	0.000519	0.000538	0.000557	0.000577	0.000598	0.000619	0.000641	0.000664	0.000687
-3.1	0.000711	0.000736	0.000762	0.000789	0.000816	0.000845	0.000874	0.000904	0.000935	0.000968
-3.0	0.001001	0.001035	0.001070	0.001107	0.001144	0.001183	0.001223	0.001264	0.001306	0.001350
-2.9	0.001395	0.001441	0.001489	0.001538	0.001589	0.001641	0.001695	0.001750	0.001807	0.001866
-2.8	0.001926	0.001988	0.002052	0.002118	0.002186	0.002256	0.002327	0.002401	0.002477	0.002555
-2.7	0.002635	0.002718	0.002803	0.002890	0.002980	0.003072	0.003167	0.003264	0.003364	0.003467
-2.6	0.003573	0.003681	0.003793	0.003907	0.004025	0.004145	0.004269	0.004396	0.004527	0.004661
-2.5	0.004799	0.004940	0.005085	0.005234	0.005386	0.005543	0.005703	0.005868	0.006037	0.006210
-2.4	0.006387	0.006569	0.006756	0.006947	0.007143	0.007344	0.007549	0.007760	0.007976	0.008198
-2.3	0.008424	0.008656	0.008894	0.009137	0.009387	0.009642	0.009903	0.010170	0.010444	0.010724
-2.2	0.011011	0.011304	0.011604	0.011911	0.012224	0.012545	0.012874	0.013209	0.013553	0.013903
-2.1	0.014262	0.014629	0.015003	0.015386	0.015778	0.016177	0.016586	0.017003	0.017429	0.017864
-2.0	0.018309	0.018763	0.019226	0.019699	0.020182	0.020675	0.021178	0.021692	0.022216	0.022750
-1.9	0.023295	0.023852	0.024419	0.024998	0.025588	0.026190	0.026803	0.027429	0.028067	0.028717
-1.8	0.029379	0.030054	0.030742	0.031443	0.032157	0.032884	0.033625	0.034379	0.035148	0.035930
-1.7	0.036727	0.037538	0.038364	0.039204	0.040059	0.040929	0.041815	0.042716	0.043633	0.044565
-1.6	0.045514	0.046479	0.047460	0.048457	0.049471	0.050503	0.051551	0.052616	0.053699	0.054799
-1.5	0.055917	0.057053	0.058208	0.059380	0.060571	0.061780	0.063008	0.064256	0.065522	0.066807
-1.4	0.068112	0.069437	0.070781	0.072145	0.073529	0.074934	0.076359	0.077804	0.079270	0.080757
-1.3	0.082264	0.083793	0.085343	0.086915	0.088508	0.090123	0.091759	0.093418	0.095098	0.096801
-1.2	0.098525	0.100273	0.102042	0.103835	0.105650	0.107488	0.109349	0.111233	0.113140	0.115070
-1.1	0.117023	0.119000	0.121001	0.123024	0.125072	0.127143	0.129238	0.131357	0.133500	0.135666
-1.0	0.137857	0.140071	0.142310	0.144572	0.146859	0.149170	0.151505	0.153864	0.156248	0.158655
-0.9	0.161087	0.163543	0.166023	0.168528	0.171056	0.173609	0.176185	0.178786	0.181411	0.184060
-0.8	0.186733	0.189430	0.192150	0.194894	0.197662	0.200454	0.203269	0.206108	0.208970	0.211855
-0.7	0.214764	0.217695	0.220650	0.223627	0.226627	0.229650	0.232695	0.235762	0.238852	0.241964
-0.6	0.245097	0.248252	0.251429	0.254627	0.257846	0.261086	0.264347	0.267629	0.270931	0.274253
-0.5	0.277595	0.280957	0.284339	0.287740	0.291160	0.294599	0.298056	0.301532	0.305026	0.308538
-0.4	0.312067	0.315614	0.319178	0.322758	0.326355	0.329969	0.333598	0.337243	0.340903	0.344578
-0.3	0.348268	0.351973	0.355691	0.359424	0.363169	0.366928	0.370700	0.374484	0.378281	0.382089
-0.2	0.385908	0.389739	0.393580	0.397432	0.401294	0.405165	0.409046	0.412936	0.416834	0.420740
-0.1	0.424655	0.428576	0.432505	0.436441	0.440382	0.444330	0.448283	0.452242	0.456205	0.460172
0.0	0.464144	0.468119	0.472097	0.476078	0.480061	0.484047	0.488033	0.492022	0.496011	0.500000



A-4 APPENDIX A STATISTICAL TABLES AND CHARTS

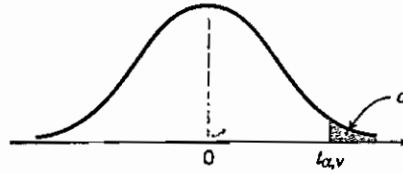


Table II Percentage Points $t_{\alpha, \nu}$ of the t Distribution

	.40	.25	.10	.05	.025	.01	.005	.0025	.001	.0005
1	.325	1.000	3.078	6.314	12.706	31.821	63.657	127.32	318.31	636.62
2	.289	.816	1.886	2.920	4.303	6.965	9.925	14.089	23.326	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	7.453	10.213	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	.265	.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	.260	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
120	.254	.677	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	.253	.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

ν = degrees of freedom.

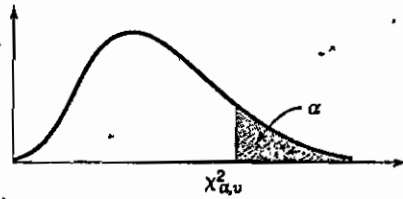


Table III Percentage Points $\chi^2_{\alpha, \nu}$ of the Chi-Square Distribution

	.995	.990	.975	.950	.900	.500	.100	.050	.025	.010	.005
1	.00+	.00+	.00+	.00+	.02	.45	2.71	3.84	5.02	6.63	7.88
2	.01	.02	.05	.10	.21	1.39	4.61	5.99	7.38	9.21	10.60
3	.07	.11	.22	.35	.58	2.37	6.25	7.81	9.35	11.34	12.84
4	.21	.30	.48	.71	1.06	3.36	7.78	9.49	11.14	13.28	14.86
5	.41	.55	.83	1.15	1.61	4.35	9.24	11.07	12.83	15.09	16.75
6	.68	.87	1.24	1.64	2.20	5.35	10.65	12.59	14.45	16.81	18.55
7	.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.01	18.48	20.28
8	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.53	20.09	21.96
9	1.73	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.02	21.67	23.59
10	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.48	23.21	25.19
11	2.60	3.05	3.82	4.57	5.58	10.34	17.28	19.68	21.92	24.72	26.76
12	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.34	26.22	28.30
13	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.74	27.69	29.82
14	4.07	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.12	29.14	31.32
15	4.60	5.23	6.27	7.26	8.55	14.34	22.31	25.00	27.49	30.58	32.80
16	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.85	32.00	34.27
17	5.70	6.41	7.56	8.67	10.09	16.34	24.77	27.59	30.19	33.41	35.72
18	6.26	7.01	8.23	9.39	10.87	17.34	25.99	28.87	31.53	34.81	37.16
19	6.84	7.63	8.91	10.12	11.65	18.34	27.20	30.14	32.85	36.19	38.58
20	7.43	8.26	9.59	10.85	12.44	19.34	28.41	31.41	34.17	37.57	40.00
21	8.03	8.90	10.28	11.59	13.24	20.34	29.62	32.67	35.48	38.93	41.40
22	8.64	9.54	10.98	12.34	14.04	21.34	30.81	33.92	36.78	40.29	42.80
23	9.26	10.20	11.69	13.09	14.85	22.34	32.01	35.17	38.08	41.64	44.18
24	9.89	10.86	12.40	13.85	15.66	23.34	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	24.34	34.28	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	25.34	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	26.34	36.74	40.11	43.19	46.96	49.65
28	12.46	13.57	15.31	16.93	18.94	27.34	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	28.34	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	29.34	40.26	43.77	46.98	50.89	53.67
40	20.71	22.16	24.43	26.51	29.05	39.34	51.81	55.76	59.34	63.69	66.77
50	27.99	29.71	32.36	34.76	37.69	49.33	63.17	67.50	71.42	76.15	79.49
60	35.53	37.48	40.48	43.19	46.46	59.33	74.40	79.08	83.30	88.38	91.95
70	43.28	45.44	48.76	51.74	55.33	69.33	85.53	90.53	95.02	100.42	104.22
80	51.17	53.54	57.15	60.39	64.28	79.33	96.58	101.88	106.63	112.33	116.32
90	59.20	61.75	65.65	69.13	73.29	89.33	107.57	113.14	118.14	124.12	128.30
100	67.33	70.06	74.22	77.93	82.36	99.33	118.50	124.34	129.56	135.81	140.17

ν = degrees of freedom.



1. (10 %) Calculate the difference in pressure between points A and B in Fig. 1 and express it as $P_B - P_A$.

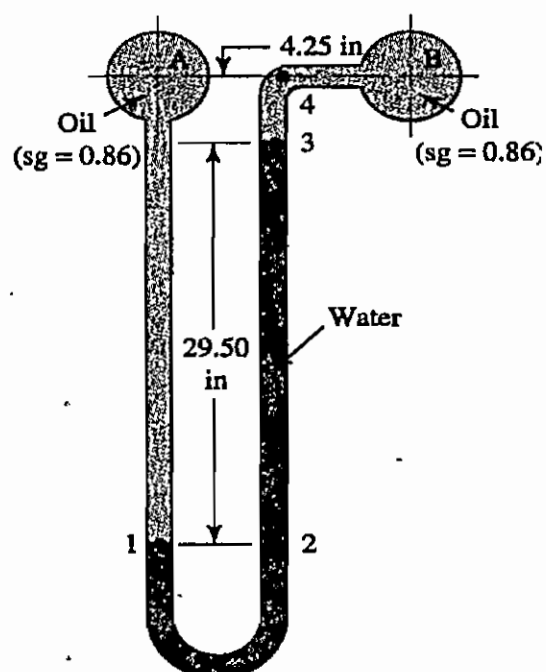


Fig. 1



2. (10 %) A dam (Fig. 2) has a parabolic shape $z/z_0 = (x/x_0)^2$ as show in Fig. E2.7a, with $x_0 = 10$ ft and $z_0 = 24$ ft. The fluid is water, $\gamma = 62.4$ lbf/ft³, and atmospheric pressure may be omitted. Computer the forces F_H and F_V on the dam and their line of action. The width of the dam is 50 ft.

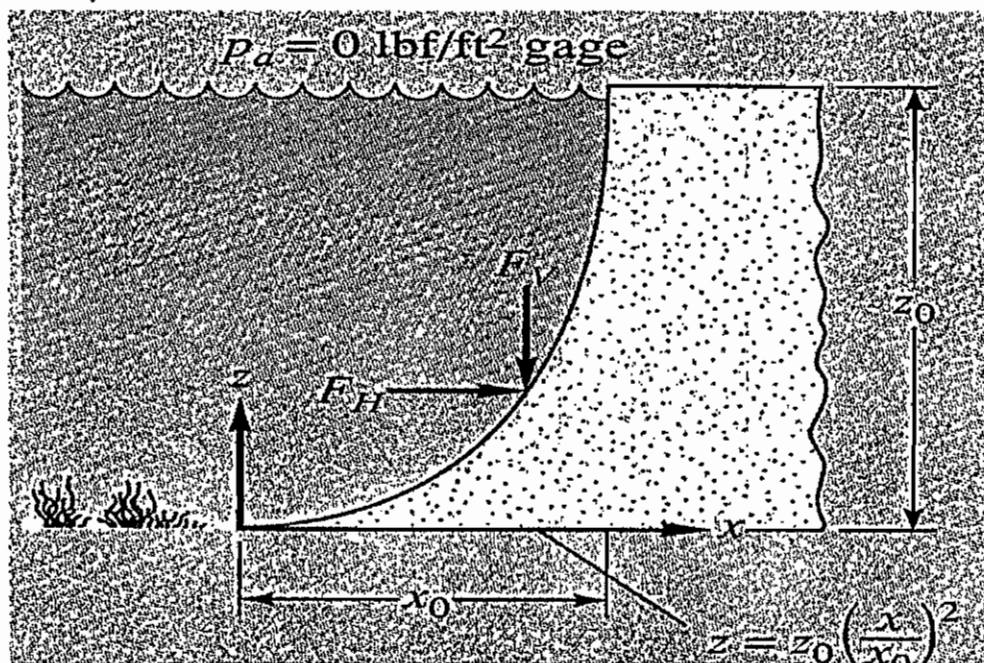


Fig. 2

3. (10 %) Determine if the flow is laminar or turbulent if water at 70°C flows in a 1-in Type K copper tube ($\nu = 4.11 \times 10^{-7}$ m²/s, $D = 0.02527$ m and $A = 5.017 \times 10^{-4}$ m²) with a flow rate of 285 L/min.



4. (20 %) The venture meter shown in Fig. 3 carries water at 60°C . The specific gravity of the gage fluid in the manometer is 1.25. Calculate the velocity of flow at section A and the volume flow rate of water. The areas for the 200 mm and 300 mm diameter sections are $3.142 \times 10^{-2} \text{ m}^2$ and $7.069 \times 10^{-2} \text{ m}^2$.

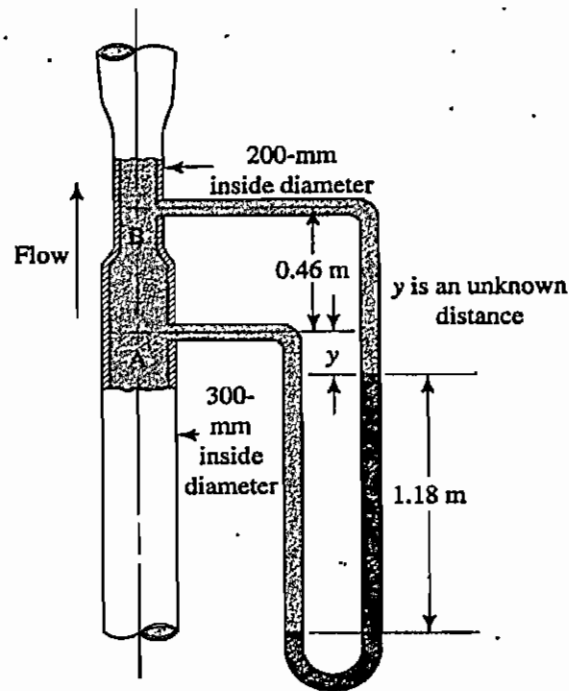


Fig. 3



5. (10%) Water at 10°C is flowing at a rate of 115 L/min through the fluid motor shown in Fig. 4. The pressure at A is 700 kPa and the pressure at B is 125 kPa . It is estimated that due to friction in the piping there is an energy loss of $4\text{ N}\cdot\text{m/N}$ of water flowing. Calculate the power delivered to the fluid motor by the water.

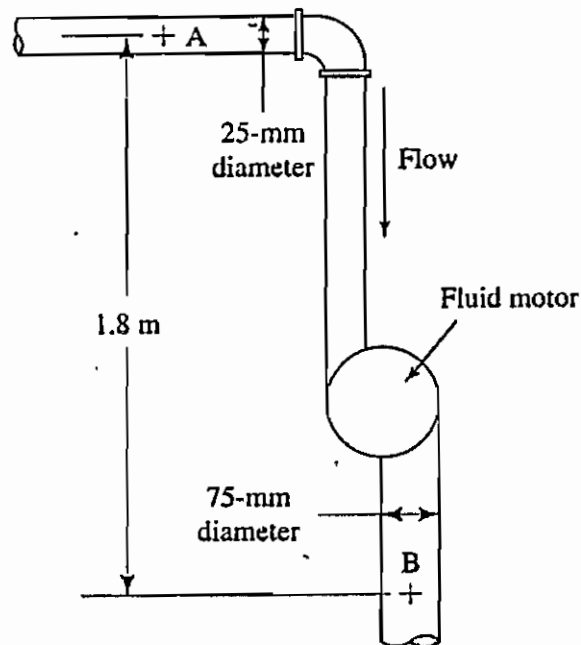


Fig. 4

6. (10%) Fig. 5 shows a jet of water with a velocity v_1 striking a vane that is moving with a velocity v_0 . Determine the forces exerted by the vane on the water if $v_1 = 20\text{ m/s}$ and $v_0 = 8\text{ m/s}$, the jet is 50 mm in diameter.

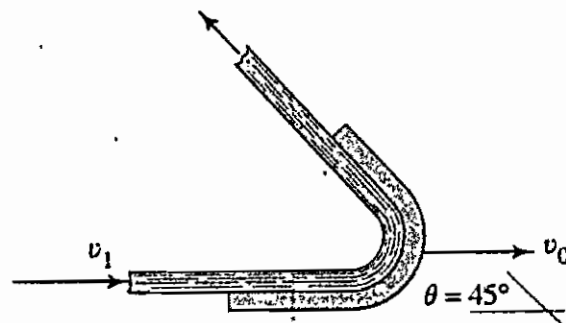


Fig. 5



7. (10%) Water is flowing in an open channel (Fig. 6) at a depth of 2 m and a velocity of 3 m/s. It then flows down a contracting chute into another channel where the depth is 1 m and the velocity is 10 m/s. Assuming frictionless flow, determine the difference in elevation of the channel floors.

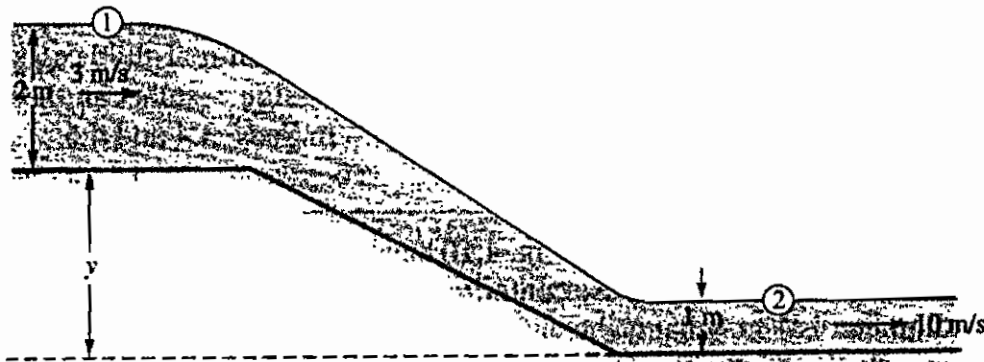


Fig. 6

8. (10%) For laminar flow conditions, what size pipe will deliver $0.0057 \text{ m}^3/\text{s}$ of medium fuel oil at 4°C (kinematic viscosity of the fluid $\nu = 6.09 \times 10^{-6} \text{ m}^2/\text{s}$)
9. (10%) Water is to flow at a rate of $30 \text{ m}^3/\text{s}$ in the concrete channel shown in Fig. 7. Find the vertical drop of the channel bottom per kilometer of length.

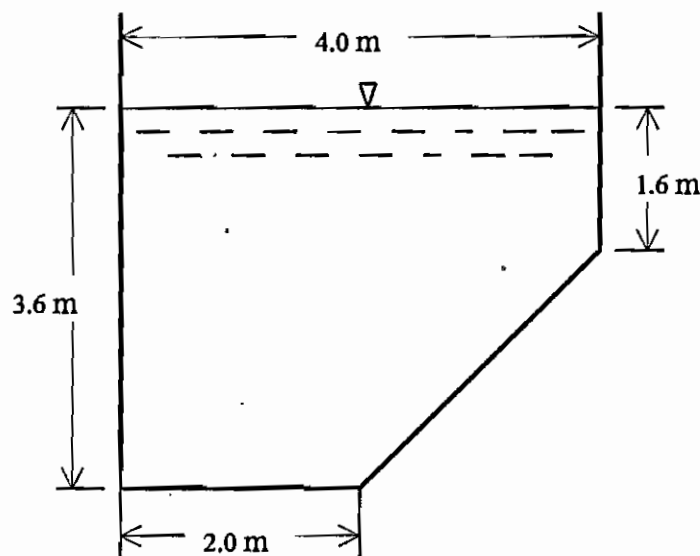


Fig. 7



1. 將數量 $300 \text{ lb}\cdot\text{s}$ 和 $52 \text{ slug}/\text{ft}^3$ 轉換為適當之 SI 單位？(10%)
2. 試求圖 1 中之力 F 表示為卡氏向量(Cartesian Vectors)。(10%)
3. 將 8 kg 之吊燈以圖 2 中所示之方式懸吊，試求繩索 AC 的長度。(彈簧 AB 的原長 $l_{AB} = 0.4 \text{ m}$ ，彈簧常數 $k_{AB} = 300 \text{ N/m}$)
(10%)
4. 試求圖 3 中作用於軸承上之等效合力大小及作用位置。
(10%)
5. 如圖 4 桿 AB 承受 200 N 之力，試求球窩頭 A 之反作用力及繩索 BD 與 BE 之張力。(10%)

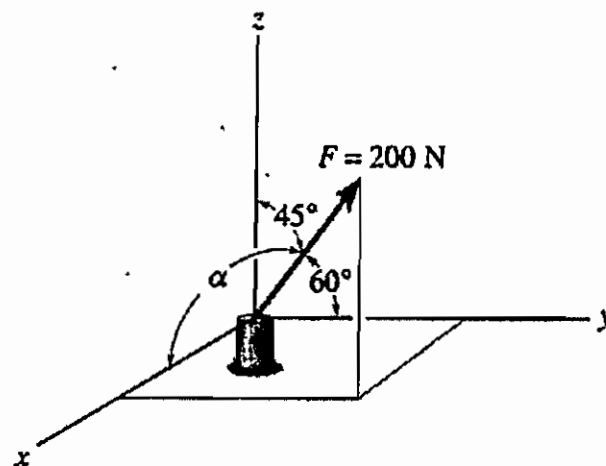


圖 1 (第 2 題)

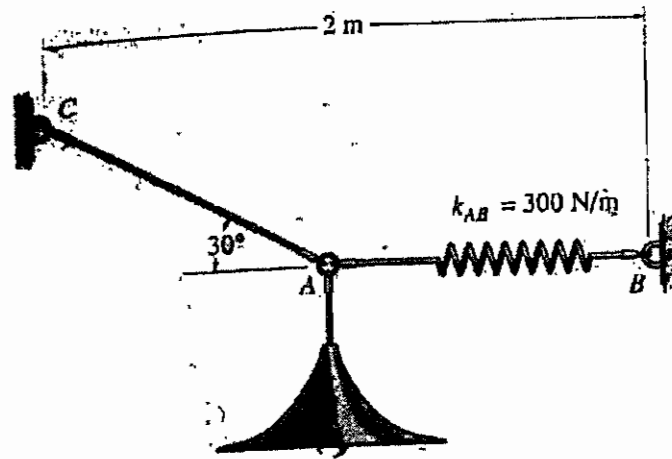


圖 2 (第 3 題)

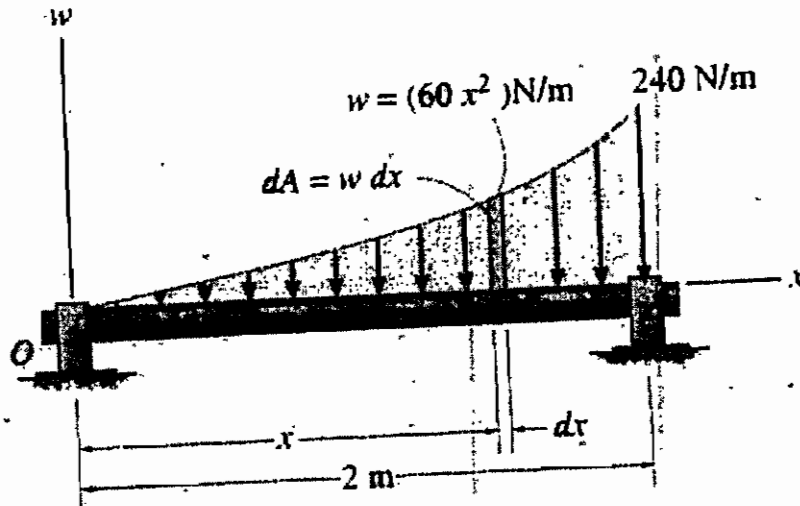


圖 3 (第 4 題)

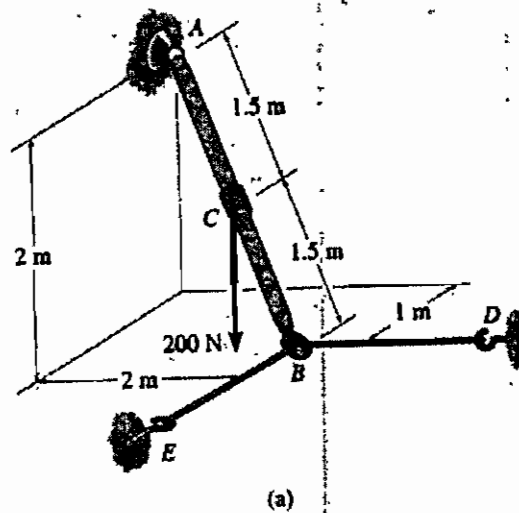
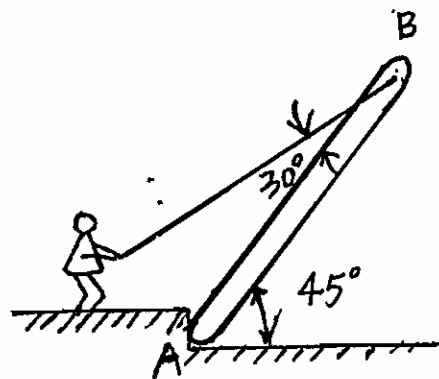


圖 4 (第 5 題)

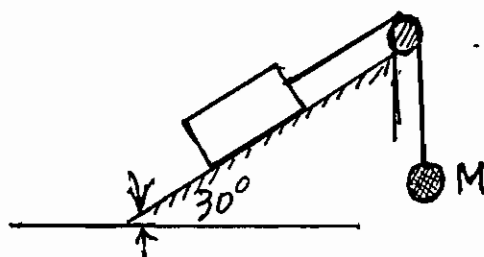


6. 如右圖，一人欲以一繩索豎立一根質量 30 kg，長 5 m 的樑，試求繩子張力及點 A 處之反力。
(10%)

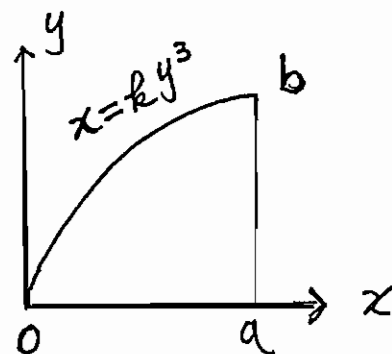


7. 已知 $F = 8i - 4j + 2k$ N，且 F 的作用線通過點 $A(-2, 4, 3)$ m，試求
(a) F 對原點 O 所生之力矩。
(b) F 對原座標 $(4, 1, -3)$ m 的 P 點所生之力矩。
(10%)

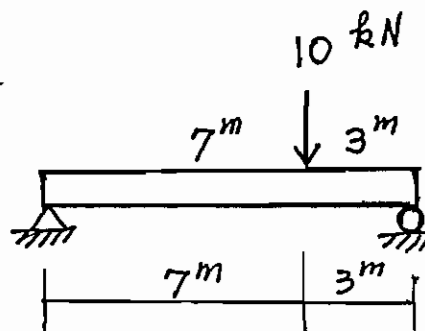
8. 100 kg 之物體置於一傾斜度 $\theta = 30^\circ$ 之粗糙面上，如右圖所示，已知接觸面的靜磨擦係數為 0.3，試求質量 M 之可能範圍，使得 100 kg 之物體既不向上移動，亦不滑下此斜面。
(10%)



9. 求由曲線下 $x = ky^3$ 自 $x=0$ 到 $x=a$ 間面積之形心位置。(10%)



10. 一簡支樑受到 10 kN 之集中負荷，求剪力及彎矩之分佈。(10%)





一、選擇題 (20題共60分，每題3分，答錯倒扣1分，不答題不計分亦不倒扣。)

1. 氫有三種同位素(^1H 、 ^2H 、 ^3H)，氯有兩種同位素(^{35}Cl 、 ^{37}Cl)，則其形成的氯化氫最大分子量為下列何者？
(a)39 (b)40 (c)41 (d)42 (e)43
2. 具有 142 kJ/mol 能量的光電子波長為下列何者？($h=6.626\times 10^{-34}\text{J}\cdot\text{s}$)
(a) $6.42\times 10^{-7}\text{m}$ (b) $7.42\times 10^{-7}\text{m}$ (c) $8.42\times 10^{-7}\text{m}$ (d) $9.42\times 10^{-7}\text{m}$ (e) $1.42\times 10^{-6}\text{m}$
3. 下列何者可用以玻璃蝕刻？
(a)HF (b)HCl (c)HBr (d)HI (e) HNO_3
4. 在 BrF_2^- 中 Br 有多少對未共用電子對(lone pairs)？
(a)0 (b)1 (c)2 (d)3 (e)4
5. 按分子軌域圖解釋 Li_2 (Li 原子序=3)，則下列敘述何者正確？
(a) 鍵結數為1，分子不會穩定 (b) 鍵結數為1，分子會穩定 (c) 鍵結數為2，分子不會穩定 (d) 鍵結數為2，分子會穩定 (e) 以上皆非。
6. 下列何種組合必為自發性反應(spontaneous)？
(a) ΔH 為正值， ΔS 為正值，
(b) ΔH 為正值， ΔS 為負值
(c) ΔH 為負值， ΔS 為正值
(d) ΔH 為負值， ΔS 為負值
(e) 以上皆非。
7. 在 Ar、 Cl_2 、 CCl_4 和 HNO_3 中何者俱有分子間氫鍵？
(a)Ar (b) Cl_2 (c) CCl_4 (d) HNO_3 (e) 以上皆非。
8. 如果人類血液中鉛濃度大於 $10^{-5}\text{g}/100\text{mL}$ ，就被認為是鉛中毒，這時血中鉛濃度相當於多少 ppb？(設 1 mL 的血液重 1g)
(a)1 (b)10 (c)100 (d)1000 (e)10,000。
9. 許多高能炸藥均含有下列哪二個主要元素？
(a)N、O (b)Hg、C (c)H、O (d)C、H (e) 以上皆非。
10. 按鹼性增加的順序排列下列氧化物：
 Al_2O_3 、 Cl_2O_7 、 K_2O 、 Li_2O



- (a) $\text{Cl}_2\text{O}_7 < \text{Al}_2\text{O}_3 < \text{Li}_2\text{O} < \text{K}_2\text{O}$ (b) $\text{Cl}_2\text{O}_7 < \text{Al}_2\text{O}_3 < \text{K}_2\text{O} < \text{Li}_2\text{O}$
 (c) $\text{Al}_2\text{O}_3 < \text{Li}_2\text{O} < \text{K}_2\text{O} < \text{Cl}_2\text{O}_7$ (d) $\text{Cl}_2\text{O}_7 < \text{K}_2\text{O} < \text{Li}_2\text{O} < \text{Al}_2\text{O}_3$ (e) 以上皆非。
11. 當混合等體積下列兩溶液時，何者是緩衝溶液？
 (I) 0.1M HF 和 0.1M NaF (II) 0.1M HF 和 0.1M NaOH
 (III) 0.2M HF 和 0.1M NaOH (IV) 0.1M HF 和 0.2M NaF
 (a) 只有(I)、(II), (b) 只有(III)、(IV), (c) 只有(I)、(II)、(IV),
 (d) (I)、(II)、(III)、(IV)均是, (e) 以上皆非。
12. 若 Si(4A 族元素)晶體摻雜(doped) In (3A 族元素)，則被稱為下列何者？
 (a) 導體 (b) 絕緣體 (c) n-型半導體 (d) p-型半導體 (e) 以上皆非。
13. 在超導體 $\text{YBa}_2\text{Cu}_3\text{O}_7$ 中，若 Y 的氧化數為 +3，則 Cu 的平均氧化數為多少？
 (a) +1 (b) +1.33 (c) +2 (d) +2.33 (e) +3
14. 在化合物 $[(\text{CH}_3)_2\text{C}=\text{CHCN}]$ 中， C^* 的混成軌道為下列何者？
 (a) sp (b) sp^2 (c) sp^3 (d) dsp^3 (e) 以上皆非。
15. 化合物 C_5H_{12} 有多少同分異構物？
 (a) 3 (b) 4 (c) 5 (d) 6 (e) 9
16. 酯類(ester)水解反應的產物為下列何者？
 (a) 醚類和烯類 (b) 烷類和醇類 (c) 羧酸類和醇類 (d) 酮類和醛類
 (e) 以上皆非。
17. $^{40}_{20}\text{Ca}^{2+}$ 有
 (a) 20 質子, 20 中子, 及 18 電子, (b) 22 質子, 20 中子, 及 20 電子,
 (c) 20 質子, 22 中子, 及 18 電子, (d) 22 質子, 18 中子, 及 18 電子,
 (e) 20 質子, 20 中子, 及 22 電子。
18. 3個 1-L 燒杯在 STP 狀況下。燒杯 A 含 NH_3 氣體, 燒杯 B 含 NO_2 氣體, 及燒杯 C 含 N_2 氣體。哪一個含最多分子？
 (a) 燒杯 A, (b) 燒杯 B, (c) 燒杯 C, (d) 相同, (e) 以上皆非
19. 一氣體吸收 0.0 J 熱且作功 15.2 J。氣體內能變化為：
 (a) -24.8 J, (b) 15.2 J., (c) 55.2 J, (d) -15.2 J,
 (e) 以上皆非



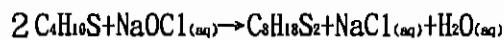
20. 下列敘述 q 及 w 於 $P = 1 \text{ atm}$ 及 $T = 370 \text{ K}$ 進行放熱程序時之正或負？



- (a) q 及 w 為負值, (b) q 為正, w 為負, (c) q 為負, w 為正,
 (d) q 及 w 皆正值, (e) q 及 w 皆為0.

二、計算選擇題 (8 題共 40 分, 每題 5 分, 答錯倒扣 2 分, 不答題不計分亦不倒扣。)

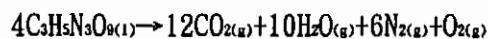
21. 丁硫醇($\text{C}_4\text{H}_{10}\text{S}$)是一種臭味來源與漂白劑(NaOCl)反應可去除臭味, 其反應如下:



多少克的丁硫醇可與 5.00 mL 的 0.0985M NaOCl 起除臭反應? ($\text{C}_4\text{H}_{10}\text{S}$ 分子量為 90.2)

- (a) 0.0888 (b) 0.0988 (c) 0.1088 (d) 0.1188 (e) 0.1288

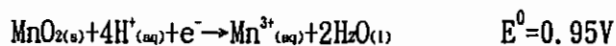
22. 假設有 0.0044 莫耳 $\text{C}_3\text{H}_5\text{N}_3\text{O}_9(\text{l})$, 放在 20.0°C 、 1atm 的 500 mL 鋼瓶中(含空氣 0.0208 莫耳), 加溫到 425°C 而爆炸。平衡方程式為:



根據理想氣體定律, 爆炸後容器內有多少 atm? ($R = 0.082 \text{ L} \cdot \text{atm}/\text{mol} \cdot \text{K}$)

- (a) 5.04 atm (b) 6.04atm (c) 7.04atm (d) 8.04atm (e) 9.04atm。

23. 已知下列反應和它們的 E^0 值:



則 $2\text{Mn}^{3+}_{(\text{aq})} + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{Mn}^{2+}_{(\text{aq})} + \text{MnO}_{2(\text{s})} + 4\text{H}^+_{(\text{aq})}$ 之 E^0 值為下列何者?

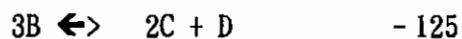
- (a) -1.18V (b) 0.59V (c) 1.18V (d) 2.49V (e) -2.49 V

24. 常壓下氣體之 21.6°C 體積為 3.62 L, 何溫度下氣體之體積為 3.45 L.

- (a) 309 K, (b) 281 K, (c) 20.6 K, (d) 294 K, (e) 326 K

25. 自下列反應 計算 $\text{B} + \text{D} \leftrightarrow \text{E} + 2\text{C}$ 之 ΔH ?

$$\Delta H \text{ (kJ/mol)}$$



- (a) 325 kJ/mol, (b) 525 kJ/mol, (c) -175 kJ/mol,

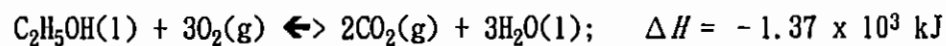


(d) - 325kJ/mol, (e) 以上皆非。

26. 下列敘述一莫耳(mole)氣體自狀態 A 膨脹至 狀態B程序時：何者為真？

- (a) When the gas expands from state A to state B, the surroundings are doing work on the system.
- (b) The amount of work done in the process must be the same, regardless of the path.
- (c) It is not possible to have more than one path for a change of state.
- (d) The final volume of the gas will depend on the path taken.
- (e) The amount of heat released in the process will depend on the path taken.

27. 考慮下列反應之敘述何者正確？



- I. 為吸熱反應
- II. 為放熱反應.
- III. enthalpy 項會因水狀態不同而異.

(a) I, (b) II, (c) III, (d) I, II, (e) II, III

28. 下列敘述何者為非？

- (a) A property that is independent of the pathway is called an intensive property.
- (b) In exothermic reaction, potential energy stored in chemical bonds is being converted to thermal energy via heat.
- (c) A state function does not depend on the system's past or future.
- (d) When a system performs work on the surroundings, the work is reported with a negative sign.
- (e) 以上皆非。