1. What is the carrying capacity of a habitat? How can carrying capacity affect the intrinsic rate of increase of a population? What factors help determine the carrying capacity?　10%

2. What are the four possible modes of bacterial nutrition?　10%

3. Describe the basis for the five-kingdom system proposed by Robert H. Whittaker and Lynn Margulis. What are the five kingdoms, and how are they distinguished from one another? What are new data led to a three-domain system, and how are they distinguished?　15%

4. What function does the renal artery have in the excretory process of a vertebrate? The ureters? The urethra? What is a nephron? What function does each pare of the nephron perform in the excretory process?　15%

5.繪圖詳述低等到高等動物神經網路的演化。　25%

6.繪圖詳述低等到高等動物心臟血管系統的演化。　25%

一、何謂體溫?(5分)人如何調節體溫？(10分)恆溫的優點為何(10分)。

二、以你的認知提出你對基因轉殖生物科技產業的見解(10分)。

三、繪圖詳述化學性神經突觸(chemical synapse)構造(10分)，神經傳導物的種類(10分)，及作用機制(15分)。

四、詳述人體血壓的調控(30分)。

1. What is the meaning of SARS? What are the pathogens? (10%)
2. Draw the structure of the following terms. (20%)

   (1) glucose   (2) methanol   (3) ethanol   (4) ATP   (5) NAD
   (6) glycine   (7) alanine   (8) methionine   (9) cysteine   (10) lysine
   (11) Adenine   (12) Guanine   (13) Cytosine   (14) Uracil   (15) Thymine
   (16) DNA   (17) RNA   (18) tRNA   (19) β-sheet   (20) α–helix

3. What is the fermentation pathway for yeast to produce ethanol from glucose? (10%)
4. What are the differences in the transcription between prokaryote and eukaryote? (20%)
5. What are the replication mechanisms of θ-form and D-loop? (10%)
6. What are amino acids that the following symbols represent? (20%)

   (1) D
   (2) asp
   (3) M
   (4) leu
   (5) I
   (6) gln
   (7) pro
   (8) W
   (9) arg
   (10) Y

7. What are the full names of the following terms? (10%)

   (1) ATP
   (2) DNA
   (3) mRNA
   (4) dNTP
   (5) SARS

一. 選擇題 (20%) (單選，10 題，每題 2 分)

( ) 1. 現代人類的生存曲線應屬於 A)Convex curve B)Straight line C)Concave curve D)Slight sigmoid type curve E)Stairstep type curve

( ) 2. 下列何者是 "Allelopathy" 的例子 A)地衣 B)青黴菌 C)水蛭 D)根瘤菌 E)鯊魚

( ) 3. 當 Production 和 Respiration 之比值等於 1 時是屬於 A)Seral Stage B)pioneer Stage C)Climax D)Aging Stage E)Cline

( ) 4. 下列何種狀況之 Cycling index 值會大於10%以上 A)生態系發展初期 B)當資源很多時 C)對於非必要元素而言 D)在寒冷的湖泊中 E)以上皆非

( ) 5. 下列何者會隨著生物群聚發展的趨勢而逐漸減低 A)Turnover time B)Mutualistic symbiosis C)Resilience stability D)Nutrient conservation E)The efficiency of energy & nutrient utilization

( ) 6. 根據 Mac Arthur 所提之島嶼生物地理平衡說，物種遷入率最低的通常是 A)離大陸較近的大島 B)離大陸較近的小島 C)離大陸較遠的大島 D)離大陸較遠的小島 E)以上皆非

( ) 7. 在海洋中具有固氮作用的是 A)鞭毛藻 B)矽藻 C)綠藻 D)藍綠藻 E)褐藻

( ) 8. 所謂酸雨(Acid rain)一般乃指 PH 小於 A)8.3 B)7.0 C)6.3 D)5.7 E)4.3 之雨水

( ) 9.下列何者較不適合利用 True census 進行研究？ A)紅檜木林 B)大象 C) 長頸鹿 D)松鼠 E)澳洲袋鼠

( ) 10. 固氮細菌的作用過程是 A) $NO_2^- \to NO_3^- \to NH_4^+$ B) $NH_4^+ \to NO_2^- \to NO_3^-$ C) $NH_4^+ \to NO_3^- \to NO_2^-$ D) $NO_3^- \to NO_2^- \to NH_4^+$ E) $NO_3^- \to NH_4^+ \to NO_2^-$

二. 解釋名詞(30%) (每題 5 分)

1. Adaptive radiation
2. Commensalism
3. Biological magnification
4. Vant Hoff's law
5. Omnivores
6. Compensation depth

三. 簡答題（請在 20 個字以內簡要回答）(10 %)

1. 要建立一個好的生態模式 (Ecological model) 必須具備哪三個要件？ (3 分)

2. 賴必格最小量定律(Liebigs Law of the Minimum)之先決條件為何？ (2 分)

3. 族群內的分散可分哪三種？(3 分)

4. 假如土壤分析所得的 Slit, Clay,及 Sand 的百分比分別是 30%, 30%,及 40%，則此土壤屬於下圖之哪一類？(2 分)
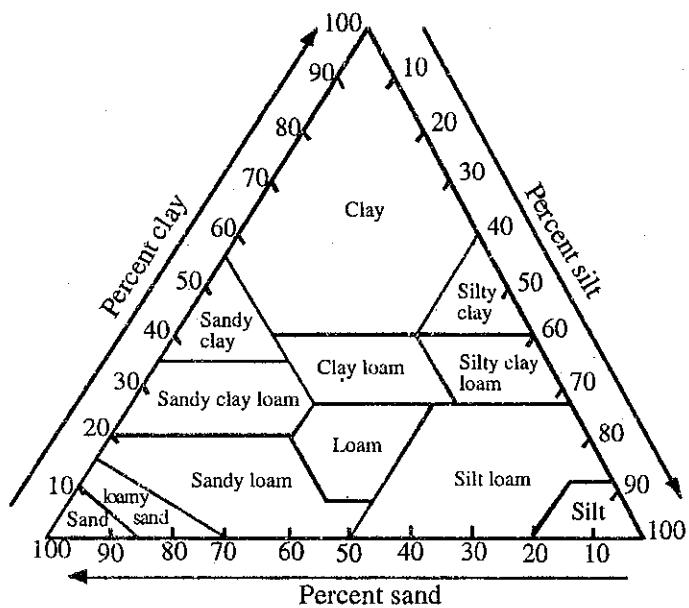
四. 問答題 (40%) (每題10分)

1. 去年9月初在台南四草保護區水域有出現許多較大型的根口類水母，在9月中下旬及10月上旬時亦陸續出現許多的小水母，但是在十月底時卻出現大量死亡的情形。請就您所知，描述這類水母的生態習性或特徵為何？這些水母為何會在此水域的大量出現？卻又在短短兩個月的時間內大量死亡？這些水母的大量出現及死亡對於當地的水域生態會有何影響？

2. 大洋表層海域生態系的基礎生產量概可分為"Regenerated production"及"New production"，這兩種生產量之定義及差異性為何？對於海域漁獲生產量各有何影響？

3. 假如高雄市政府要委託您評估蓮池潭吳郭魚的族群量大概有多少，請問您要如何進行？

4. 下圖為兩種浮游植物共同存在於一水域生態系內並受到兩種營養鹽最小量限制之情況，請說明圖中A、B、C、D、E所代表之意義為何？
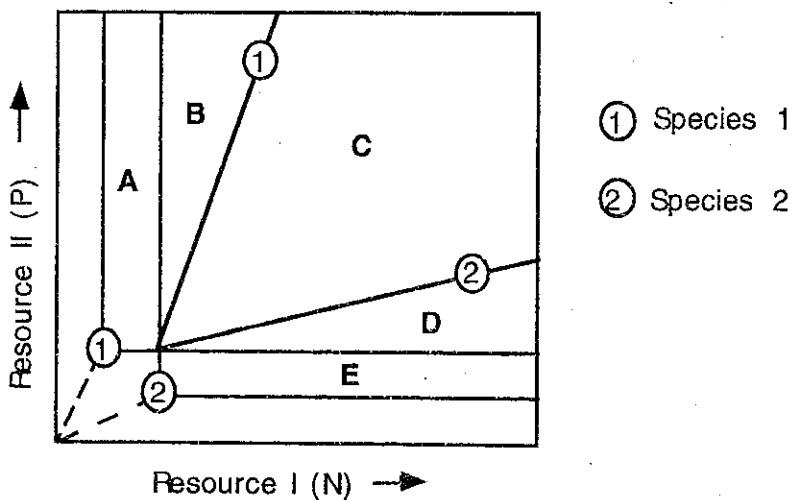
1. 假設某族群中，個人血清蛋白濃度為常態分佈(normal distribution)，其平均值
   (mean)為 4.2g/100ml,其 standard deviation 為 0.5 g/100ml。由此族群逢機取出
   9 人，並給予某劑量口服固醇類藥品，之後測得此 9 人平均血清蛋白濃度為
   3.8 g/100ml。如此結果是否顯示口服固醇類藥品降低了血清蛋白濃度？請測
   試（α=0.05）（15%）

2. 某實驗想瞭解國小四年級學生之國語程度是否有學校之間及班級之間的差
   別，逢機選取 3 個國小，每校抽 4 年級兩班，每班抽 3 個學生進行國語測驗，
   得結果如下表：請寫出（1）此實驗設計之統計模式(statistical model)並說明模式
   中各項變數（10%）；（2）列出其變方分析表中之變因項目(source of variation)及
   自由度，自由度請寫出阿拉伯數字（註：不需運算整個分析）（10%）

學校	A		B		C	
班級	1	2	1	2	1	2
學生成績	55	89	35	88	50	70
	70	62	78	74	75	82
	85	73	90	68	66	46

3. 請由下圖 A-F 中找出下列 correlation coefficient(r)最可能的圖形號碼 (9%)
   (1) r = 0
   (2) r = -0.368
   (3) r = 0.986
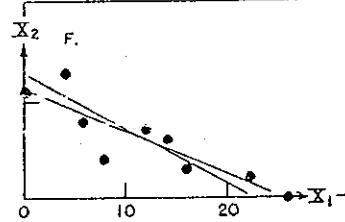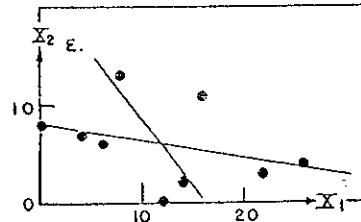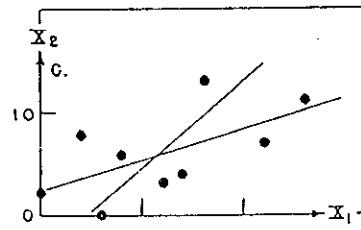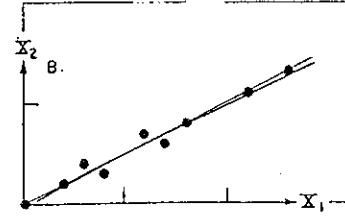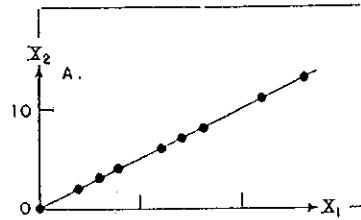
4. 某實驗想測試藥品（drug）與壓力(stress) 對人的情緒焦慮的影響，其變方分析表如下，其中 SOV(source of variation)為變因項目，SS (sum of squares)為平方和：請（1）詳細說明實驗設計內容(10%)（2）完成變方分析表中之空格 a-e(10%)

SOV	SS	df	MS
Stress	33.4	2	16.7
Drug	10.8	2	5.4
Stress*Drug	9.9	a	b
Error	c	d	e
Total	67.1	17	

5.由以下表格，請回答下列問題：

（1）解釋名詞：df, MS, F, P>F （12%）

（2）這個實驗有幾個 Location?幾個 Site? （6%）

（3）說明是屬於那一種實驗設計？(5%)

（4）由統計分析中，得到什麼結論？請一一條列說明(13%)

Table ANOVA table showing differences in the elemental compositions at the center and edge of otoliths from the Neuse and Elizabeth Rivers ($\alpha = 0.05$).

Source	df	Type 3 SS	MS	F	P > F
Center					
Mg					
Location	1	4.9×10^{-4}	4.9×10^{-4}	0.94	0.3880
Site(location)	4	2.1×10^{-3}	5.2×10^{-4}	1.51	0.2225
Error	31	1.0×10^{-1}	3.5×10^{-4}		
Zn					
Location	1	1.78×10^{-4}	1.78×10^{-4}	0.84	0.4100
Site(location)	4	8.41×10^{-4}	2.1×10^{-4}	1.08	0.3811
Error	31	6.0×10^{-3}	1.9×10^{-4}		
SR					
Location	1	0.549	0.549	5.54	0.0781
Site(location)	4	0.392	0.098	0.17	0.9522
Error	31	17.88	5.8×10^{-1}		
Ba					
Location	1	1.44×10^{-5}	1.44×10^{-5}	3.64	0.1289
Site(location)	4	1.58×10^{-5}	3.95×10^{-6}	0.20	0.9348
Error	31	6.0×10^{-4}	1.9×10^{-5}		
Edge					
Mg					
Location	1	3.29×10^{-3}	3.29×10^{-3}	14.66	0.0186
Site(location)	4	8.96×10^{-4}	2.24×10^{-4}	0.59	0.6705
Error	33	1.2×10^{-2}	3.8×10^{-4}		
Zn					
Location	1	3.57×10^{-6}	3.57×10^{-6}	0.03	0.8626
Site(location)	4	4.2×10^{-4}	1.05×10^{-4}	0.65	0.6285
Error	33	5.3×10^{-3}	1.6×10^{-4}		
Sr					
Location	1	0.211	0.211	0.76	0.4335
Site(location)	4	1.115	0.279	0.68	0.6100
Error	33	13.5	0.409		
Ba					
Location	1	2.06×10^{-3}	2.06×10^{-3}	10.86	0.0301
Site(location)	4	7.58×10^{-4}	1.9×10^{-4}	1.03	0.4059
Error	33	6.1×10^{-3}	1.8×10^{-4}		

附表 1

Table 1　Normal curve areas

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4799	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

This table is abridged from Table 1 of *Statistical Tables and Formulas*, by A. Hald (New York: John Wiley & Sons, 1952). Reproduced by permission of A. Hald and the publishers, John Wiley & Sons.

附表 2

Table 2　Percentage points of the t distribution

df	a = .10	a = .05	a = .025	a = .010	a = .005
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
inf.	1.282	1.645	1.960	2.326	2.576

From "Table of Percentage Points of the *t*-distribution." Computed by Maxine Merrington, *Biometrika*, Vol. 32 (1941), p. 300. Reproduced by permission of the *Biometrika* Trustees.

附表 3

Table 4　Percentage points of the F-distribution

Degrees of freedom　$(a = .05)$

Table 4. Percentage Points of the F-Distribution

df_2 \ df_1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	245.9	248.0	249.1	250.1	251.1	252.2	253.3	254.3
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.36
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

一、選擇題部份，共有十題，每題 5 分。將正確選項寫在答案卷上。

1. An ideal spring is hung vertically from the ceiling. When a 2.0-kg mass hangs at rest from it the spring is extended 6.0 cm from its equilibrium length. An upward external force is then applied to the mass to compress the spring so it is 10 cm shorter than its equilibrium length. While the spring is being compressed the work done by the spring is:

   a, -1.0 J

   b, -0.52 J

   c, -0.26 J

   d, 0.52 J

   e, 1.0 J

2. A disk has a rotational inertia of 6.0 kg m^2 and a constant angular acceleration of 2.0 rad/s^2. If it starts from rest the work done during the first 5.0 s by the net torque acting on it is:

   a, 0

   b, 30 J

   c, 60 J

   d, 300 J

   e, 600 J

3. A 0.25-kg block oscillates on the end of the spring with a force constant of 200 N/m. If the oscillation is started by elongating the spring 0.15 m and giving the block a speed of 3.0 m/s, then

   a. 0.13 m

   b. 0.18 m

   c. 3.7 m

   d. 5.2 m

   e. 13 m

4. When work W is done on an ideal gas of diatomic molecules in thermal isolation the increase in the total rotational energy of the molecules is:

   a. 0

   b. W/3

   c. 2W/3

   d. 2W/5

   e. W

5. A solid insulating sphere of radius R contains a uniform volume distribution of positive charge. Which of the graphs below correctly gives the magnitude E of the electric field as a function of r?

a.   b.   c.

d.   e.
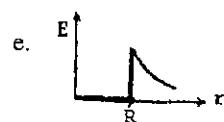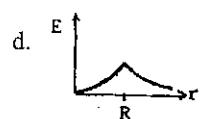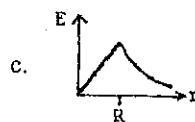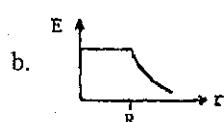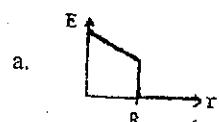
6. At one instant an electron (charge $= -1.6 \times 10^{-19}$ C) is moving in the xy plane, the components of its velocity being $v_x = 5 \times 10^5$ m/s and $v_y = 3 \times 10^5$ m/s. A magnetic field of 0.8 T is in the positive z direction. At that instant the magnitude of the magnetic force on the electron is:

   a. 0
   b. 3.8×10^{-14} N
   c. 5.1×10^{-14} N
   d. 6.4×10^{-14} N
   e. 7.5×10^{-14} N

7. A wire carrying a large current I from east to west is placed over an ordinary magnetic compass. The "N" of the compass needle will point:

   a. north
   b. south
   c. east
   d. west
   e. the compass will act as an electric motor, hence the needle will keep rotating

8. Immediately after switch S in the circuit shown is closed, the current through the battery shown is:

   a. 0
   b. V_o/R_1
   c. V_o/R_2
   d. $V_o/(R_1 + R_2)$
   e. $V_o(R_1 + R_2)/(R_1 R_2)$
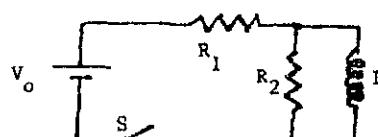
9. A convex refracting surface has a radius of 12 cm. Light is incident in air (n = 1) and refracted into a medium with an index of refraction of 2. To obtain light with rays parallel to the optic axis after refraction a point source should be placed on the axis:
   a. 3 cm from the surface
   b. 6 cm from the surface
   c. 12 cm from the surface
   d. 18 cm from the surface
   e. 24 cm from the surface

10. Figure (i) shows a double-slit pattern obtained using monochromatic light. Consider the following five possible changes in conditions:

(i) ⊔⊔⊔⊔⊔ (ii) ⊔⊔⊔⊔⊔⊔⊔

   1. decrease the frequency
   2. increase the frequency
   3. increase the width of each slit
   4. increase the separation between the slits
   5. decrease the separation between the slits

Which of the above should change Figure (i) into Figure (ii)?
   a. 3 only
   b. 5 only
   c. 1 and 3 only
   d. 1 and 5 only
   e. 2 and 4 only

二、計算題部份，共有 5 題，每題 10 分。

(1) A child's toy consists of a small wedge that has an acute angle θ as shown in the right Figure. The sloping side of the wedge is frictionless and a mass m on it remains at constant height if the wedge is spun at a certain constant speed. The wedge is spun by rotating a vertical rod that is firmly attached to the wedge at the bottom end. Find the speed of the mass m when it sits a distance L up along the sloping side.
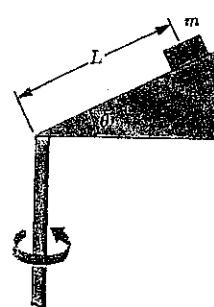
(2) A particle of mass m, moving with speed v, collides obliquely with an identical particle initially at rest. If the collision is completely elastic, what is the angle between the moving directions of these two particles after collision?

(3) Two waves in a long string are given by

$$y_1 = (0.015m)\cos(\frac{x}{2} - 40t)$$

$$y_2 = (0.015m)\cos(\frac{x}{2} + 40t)$$

where the y's and x are in m and t is in s. (a) Determine the positions of the nodes of the resulting standing wave. (b) What is the maximum displacement at the position $x = 0.4$ m?

(4) A large storage tank filled with water develops a small hole in its side at a point 16 m below the water level. If the rate of flow from the leak is 2.5 x 10^{-3} m²/min, determine (a) the speed at which the water leaves the hole and (b) the diameter of the hole.

(5) A long straight wire is parallel to one edge and is in the plane of a single turn rectangular loop as in the Figure below. (a) If the current in the long wire varies in time as $I = I_o e^{-t/\tau}$, determine the induced emf in the loop.

(b) Calculate the value for the induced emf at $t = 5$ s taking $I_o = 10$ A, d = 3 cm, $a = 6$ cm, $b = 15$ cm, and $\tau = 5$ s.
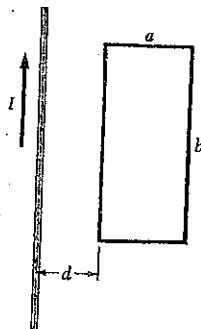
1. 地球半徑為 6300 km，在北緯 30 度，(a)離開地球自轉軸的距離是多少？(b)表面切線速度是多少？(c)科氏力參數 f 是多少？(d)畫圖表示 f vs. 緯度 Φ　(e)若有一公斤重的水團在 30°N 以 20 cm/s 速度向東移動，則柯氏力的大小和方向是什麼？(f)假如地球自轉週期變成 48 小時，則在 30°N 的 f 是多少？(12 %)

2. 解釋名詞 (20 %)
   (a) 1 節的速度 = ? m/s
   (b) 1 緯度的距離 = ? 浬 = ? km
   (c) σ_t
   (d) AABW
   (e) T-S diagram
   (f) trade winds
   (g) geostrophic equation
   (h) 1 Sv = ? m^3/s
   (i) buoyancy frequency
   (j) greenhouse effect

3. 考慮一個地中海，沒有 inflow 和 outflow, E-P>0，因此鹽度甚高。它的平均深度為 2500 m，表面積為 2.5×10^6 km^2，現在的平均鹽度為 36.5 psu，密度為 1029 kg/m^3。如果在若干年前，因為 E >> P，所以鹽度增加到 40 psu，請計算當時的水深？(提示:當鹽度增加 ΔS 時，密度增加了 $\Delta\rho = \rho^* \gamma^* \Delta S$，ρ 為密度)，$\gamma = 7 \times 10^{-4}$ $(psu)^{-1}$，記得要用到質量守恆和鹽量守恆) (17 %)

4. 何謂行星渦度？ 相對渦度？ 位渦度？ 在北半球有一由東向西的洋流，假如此洋流遇到一淺灘使得水深減少，則此洋流會有何影響？ 解釋之。 (10 %)

5. 此圖為 Gulf Stream 的水溫分佈斷面，假設 4000 m 深處的流為靜止，請問(a)離岸 300 km 處，近海面的流向？(b)柯氏力和壓力梯度力是何方向？(c)畫出海面高度的分佈圖？(d)解釋你是根據什麼原理得到上述結論？(15 %)
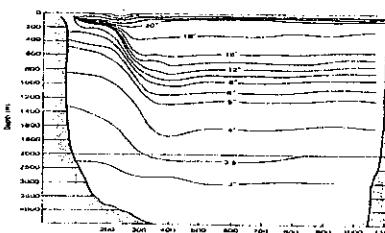
6. 波浪由深海傳到淺海，請問深水波的適用範圍？ 相位速度如何表示？ 如果週期為 10 秒，則波數和相位速度是多少？ 淺水波的適用範圍？ 相位速度如何表示？ 如果要將波浪能量拿來使用，請問波能的公式如何表示？ 波能傳播的速度是多少？ (13 %)

7. 如圖，考慮地球和月球系統的平衡，在地球的近月點(a 點)和遠月點(b 點)的引潮合成力是怎樣推導出來的？ 結果(力的大小和方向)有何不同？ M_2 的週期是多少？ 為什麼會有 M_2？ 何謂 spring tide？ (13 %)
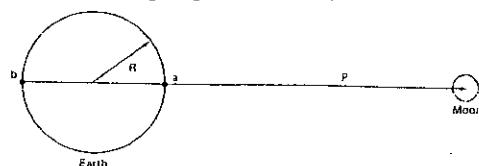
一、　解釋名詞（每小題 3 分，共 30 分）

1. aquifer
2. asthenosphere
3. geotherm
4. regional metamorphism
5. fractional crystallization
6. ophiolite suite
7. Principle of uniformitarianism
8. slump
9. Tananao Metamorphic Complex
10. turbidite

二、　問答題（1~5 題每小題 6 分，6~9 題每小題 10 分，共 70 分）

1. 試列舉三種因冰川侵蝕所造成的地形。(6%)

2. 九二一地震時，南投國姓鄉的九份二山山崩造成重大傷亡，試從地質的角度說明此大規模山崩發生的原因。(6%)

3. 影響變質作用的主要因素有那些？(6%)

4. 地下水中常見的污染物與污染源有那些？(6%)

5. 說明變質岩中的葉理（foliation）是如何形成的？和節理（joint）有甚麼不同？(6%)

6. 試敘述如何從地震測站的資料來定出地震發生時的震央位置。(10%)

7. （a）曲流（meander）是如何形成的？（b）在有些地方為了排洪，常常以人工將曲流截彎取直，請問這樣的作法有什麼正面與負面的效應。(10%)

8. 何謂板塊地體構造學說（plate tectonics）？詳細說明之。(10%)

9. 黏土礦物是很重要的礦產資源，請問黏土礦物是如何形成的？試寫出一個反應式，詳細說明之。(10%)

1. 求下列極限：(15 分)

(a) $\lim_{n \to \infty} n - \dfrac{1}{\ln(1+\frac{1}{n})}$ (b) $\lim_{x \to \infty} \dfrac{\ln x}{x^\alpha}$ ($\alpha > 0$)   (c) $\lim_{n \to \infty} n(e^{1/n}-1)$。

2. 判斷下列級數是否收斂。(10 分)

(a) $\displaystyle\sum_{n=1}^{\infty} \dfrac{2n^2-1}{n^3+8}$　　　　(b) $\displaystyle\sum_{n=2}^{\infty} \dfrac{(-1)^n}{\sqrt{n^2-n}}$

3. 一份外銷訂單要求廠商製作一批容量 96 立方公分的無蓋長方形盒子。製作盒側邊的材料是 \$1/公分^2，而製作盒底的材料是 \$3/公分^2。請問廠商要用何種方式以最少的成本來達到要求？(15 分)

4. 判斷對錯：$f(x) = x^4 + ax + b$ 最多可以有四個實根。$(a,b \in \mathbb{R})$(10 分)

5. 計算瑕積分 $\int_0^1 \ln x \, dx$。(10 分)

6. 令 $w = \displaystyle\int_{x^2}^{xy} \sin t \, dt$，$x = u+v$，$y = u^2 - v^2$。求 $\frac{\partial w}{\partial u}$ 和 $\frac{\partial w}{\partial u}$。(10 分)

7. 令 $I_n = \displaystyle\int_0^\infty \dfrac{x^{2n-1}}{(x^2+1)^{n+3}}$，$n \geq 1$。設 $I_n = \alpha_n I_{n-1}$，$n \geq 2$。(20 分)

(a) 求 α_n。

(b) 求 $\lim_{n \to \infty} \alpha_n$。

8. 計算 $\displaystyle\iint_D (x^2+y^2)\, dxdy$，其中 $D = \{(x,y) : 0 \leq x \leq 3, x^2 \leq y \leq 3x\}$。
(10 分)

流體力學

一. 解釋名詞 (20%)

(1) Bernoulli equation

(2) vorticity

(3) hydraulic jump

(4) Moody chart

(5) Froude number

二. (20%) A 6-cm diameter sphere is tested in water at a velocity of 3 m/s and has a measured drag of 6 Newton. What will be the velocity and drag force of a 2-m-diameter weather balloon moving in air under similar conditions? Given the viscosity and density for water and air are:

Water:　$\mu_w = 10^{-3}$ kg/(m.s)　　$\rho_w = 1000$ kg/m^3

Air:　　$\mu_a = 10^{-5}$ kg/(m.s)　　$\rho_a = 1$ kg/m^3

三. (20%)二度空間穩流的速度場是 $V(x, y) = Ax\vec{i} - Ay\vec{j}$，其中 A 是常數，試求(a)流動的流線方程式，並繪出它在第一象限的圖形(b)流動的加速度。

四. 下列速度場何者為無旋性流動(irrotational flow):

(a) $V = 2xy\vec{i} + (x^2-y^2)\vec{j}$

(b) $V = -(2xy+x)\vec{i} + (y^2+y-x^2)\vec{j}$

並求出無旋流動之速度位(velocity potential)和流函數(stream function)。 (20%)

五. (20%)如附圖所示，如無摩擦損失，試求水在管內之流量。
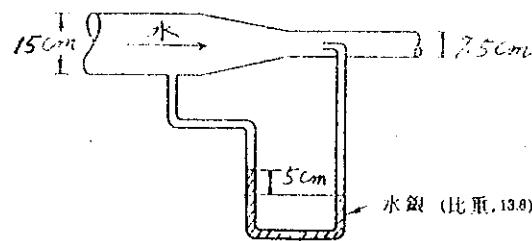
一、　解釋名詞（每小題3分，共15分）

1. polymorphism
2. zoned mineral
3. *C*2/m
4. space group
5. solid solution

二、　問答題（共85分）

1. 石英破碎時會有貝殼狀的斷口，而黑雲母破碎時卻有很平整的解理面，這是為什麼？（10%）

2. (a) 晶體的基本對稱元素有那幾種？試說明之。(b) 每一種礦物晶體都會具有的對稱元素是什麼？（10%）

3. (a) 試以玄武岩和花崗岩為例，寫出兩者中的主要組成礦物。(b)為什麼在大部分的火成岩中，氧化物和硫化物礦物都只是附屬礦物而已，試說明之。（10%）

4. 繪圖說明 CCP（cubic-close-packing）結構和 HCP（hexagonal-close-packing）結構。（10%）

5. 矽酸鹽礦物可分為那幾大類？試繪圖說明並各舉一個礦物實例。（15%）

6. (a) 在某國立大學就讀地質系的小明採了一塊深色的岩石，他想鑑定並且確認這是什麼岩石，請問他需要從這塊石頭身上獲得什麼資料才能用來鑑定它？
   (b) 他可以用那些方法來獲得這些資料？
   (c) 小明分析了這塊石頭中的一個礦物的化學成份，得到以下分析值：$SiO_2 = 50.38\%$，$Al_2O_3 = 3.01\%$，$TiO_2 = 0.45\%$，$Fe_2O_3 = 1.95\%$，$FeO = 4.53\%$，$MgO = 14.69\%$，$CaO = 24.32\%$，$Na_2O = 0.46\%$（重量百分比），試計算此礦物之化學式（需寫出計算過程，原子量 $O = 16.0$，$Si = 28.1$，　$Al = 27.0$，$Ti = 47.9$，$Fe = 55.8$，$Mg = 24.3$，$Ca = 40.1$，$Na = 23.0$），
   (d) 根據此化學式判斷是何種礦物，
   (e) 並且推斷他用的是什麼分析方法來得到這個成分。（20%）

7. 底下兩個圖為兩種礦物的結構圖，請分別說明其 (a) 布拉維晶格型式，(b) 陽離子配位數，(c) 結構名稱。（10%）

(A)　　　　　　　　　　(B)
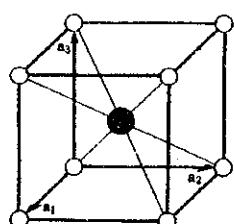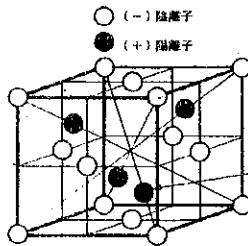
1. Explain the following terms. (14%)

(a) configuration (b) conformation (c) tautomerism (d) epimer
(e) diastereoisomer (f) Saytzeff's rule (g) spin-spin coupling

2. Complete the following reactions. (18%)

(a)

 $C_6H_5CO_3H$ → ?

(b)

 + $\xrightarrow[\text{benzene}]{35\,^\circ C}$? $\xrightarrow[\text{1,3-butadiene}]{100\,^\circ C}$?

(c)

 $\xrightarrow[\text{pyridine}]{Ac_2O}$?

(d)

 + $CHCl_3$ + KOH $\longrightarrow$?

(e)

 $\xrightarrow{CH_2N_2}$?
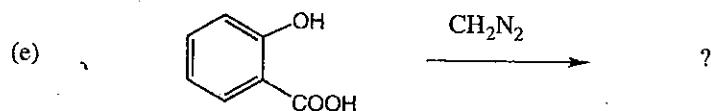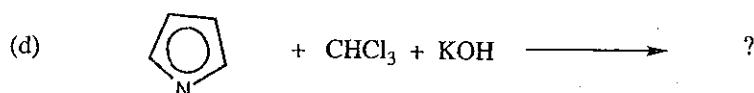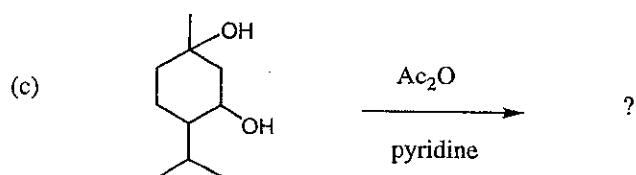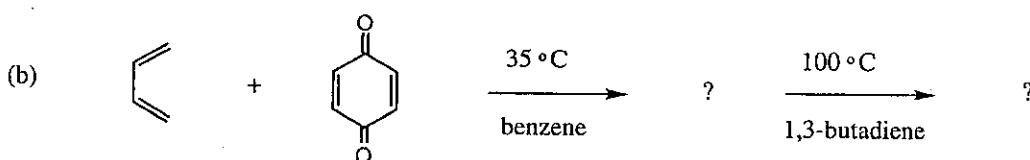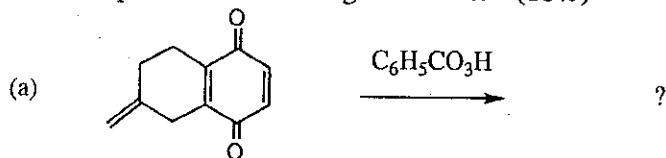
3. How many chiral centers in each of the following natural products? (8%)

(a)

(b)

(c)

(d)
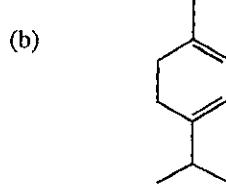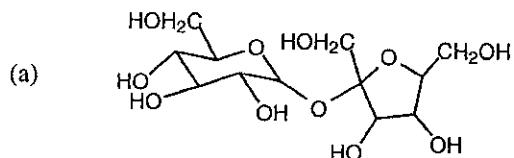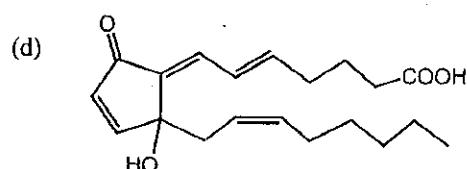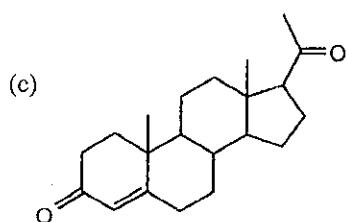
4. Why the orientation of nitration in toluene appears predominantly at ortho and para position?. (4%)

5. Give examples for the following name reactions (6%)
(a) Friedel-Craft acylation (b) Wittig reaction

6. How to determine the structures of natural products. Describe the methods you would apply for step by step. (10%)

7. Deduce the structure which would be consistent with the spectra and molecular formula given. (40%)

(a) $C_9H_{12}O$ ^{1}H-NMR: δ 6.40 (3H, brs), 3.62 (3H, s), 2.20 (6H, s)

^{13}C-NMR: δ 162 (singlet), 140 (singlet), 124 (doublet), 113 (doublet), 56 (quartet), 22 (quartet)

IR: 1630, 1600, 1470, 830, 685 cm^{-1}

(b) $C_8H_{10}O$ ^{1}H-NMR: δ 7.24 (5H, brs), 4.43 (2H, s), 3.34 (3H, s)

(c) $C_4H_5NO_2$ ^{1}H-NMR: δ 2.73 (4H, s)

^{13}C-NMR: δ 183.6 (singlet), 30.3 (triplet)

IR: 3200, 1680 cm^{-1}

(d) $C_4H_6O_2$ ^{13}C-NMR: δ 167.7 (singlet), 141.6 (doublet), 97.2 (triplet), 20.4 (quartet)

IR: 1760, 1645, 1380, 1210 cm^{-1}
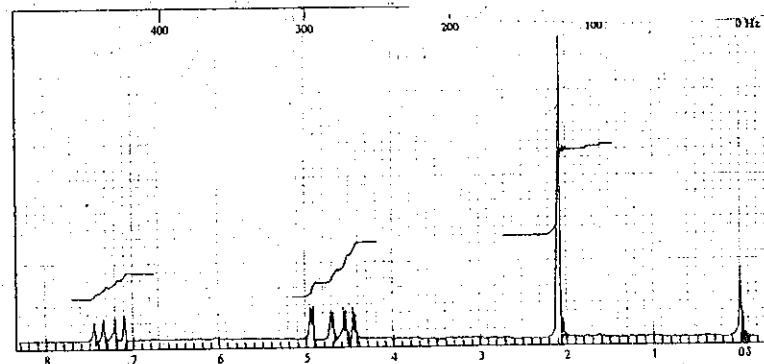
請注意：1 至 5 題爲選擇題（單選），答對每題得 4 分，答錯每題到扣 1 分，不作答則不予計分亦不扣分。　6 至 16 題中若涉及計算，請將演算過程列出，否則該題不予計分。

（4%）1. What is th pH of the solution formed by adding 50.0 ml of 1.00 M Na_2HPO_4 with 50.0 ml of 0.50 M HCl？（For H_3PO_4, $pKa_1 = 2$, $pKa_2 = 7$, $pKa_3 = 12$）

　　（A）2　（B）4.5　（C）7　（D）9.5　（E）12

（4%）2. Which of the following indicators would be most useful in identifying the equivalence point of a titration for a solution that has a hydrogen ion concentration of 7×10^{-4} M at the equivalence point？

　　（A）Methyl violet（pH range for color change is $0.1 - 2.0$）

　　（B）Methyl yellow（pH range for color change is $1.2 - 2.3$）

　　（C）Methyl orange（pH range for color change is $2.9 - 4.0$）

　　（D）Methyl red（pH range for color change is $4.3 - 6.2$）

　　（E）Bromthymol blue（pH range for color change is $6.1 - 7.6$）

（4%）3. $HCrO_4^- + Ca^{2+} \rightarrow H^+ + CaCrO_4$

　　If the acid dissociation constant for $HCrO_4^-$ is K_a and the solubility product for $CaCrO_4$ is K_{sp}, which of the following gives the equilibrium expression for the reaction above？

　　（A）$K_a K_{sp}$

　　（B）K_a / K_{sp}

　　（C）K_{sp} / K_a

　　（D）$1/K_{sp} K_a$

　　（E）$K_a K_{sp}/2$

（4%）4. Which of the following is true of an electrochemical cell？

　　（A）the cathode is the site of reduction

　　（B）the anode is negatively charged

　　（C）the cell voltage is independent of concentration

　　（D）　charge is carried from one electrode to the other by metal atoms passing through the solution

　　（E）none of the above

（4%）5. $Al^{3+} + 3e^- \rightarrow Al_{(s)}$　　　　$E^o = -1.66$ V

　　　$Cr^{3+} + 3e^- \rightarrow Cr_{(s)}$　　　　$E^o = -0.74$ V

　　The standard reduction potentials for two half reactions are shown above. Which of the statements listed below will be true for the following reaction taking place under standard conditions？

　　　　　　$Al_{(s)} + Cr^{3+} \rightarrow Al^{3+} + Cr_{(s)}$

　　（A）$E^o = 2.40$ V and the reaction is not spontaneous

　　（B）$E^o = 0.92$ V and the reaction is spontaneous

　　（C）$E^o = -0.92$ V and the reaction is not spontaneous

　　（D）$E^o = -0.92$ V and the reaction is spontaneous

　　（E）$E^o = -2.40$ V and the reaction is not spontaneous

（5%）6. Calculate the molar concentration of HNO_3 （63.0 g/mol） in a solution that has a specific gravity of 1.42 and is 70 % HNO_3 （w/w）.

（10%）7. Explain the following terms：
  （a）Brønsted – Lowry acid
  （b）amphiprotic solute
  （c）amphiprotic solvent
  （d）Zwitterion
  （e）autoprotolysis

（5%）8. Distinguish the difference between a galvanic cell and an electrolytic cell.

（5%）9. Calculate $E°$ for the process
$$FeY^- + e^- \rightarrow FeY^{2-}$$
given that
$Fe^{3+} + Y^{4-} \rightarrow FeY^-$	$K_f = 10^{25}$
$Fe^{2+} + Y^{4-} \rightarrow FeY^{2-}$	$K_f = 10^{14}$
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	$E° = 0.771$ V
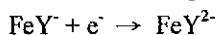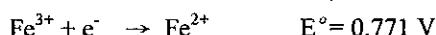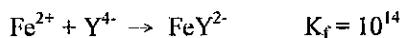
（5%）10. Why is it necessary to bubble hydrogen through the electrolyte in a hydrogen electrode？

（5%）11. In the titration of I_2 solution with $Na_2S_2O_3$, starch indicator is never added until just before chemical equivalence. Why？

（10%）12. Describe the differences between spectrophotometer and photometer and list any particular advantages possessed by one over the other.

（5%）13. What is the mechanism of charge-transfer absorption？ Why is the type of absorption of interest in analytical chemistry？

（10%）14. Briefly explain why
  （a）fluorescent emission ordinarily occurs at wavelengths that are longer than that of the excitation radiation.
  （b）fluorescence measurements have the capability of greater sensitivity than absorbance measurements.

（10%）15. The distribution coefficient for chemical Q between n-hexane and water is 10. Calculate the concentration of Q remaining in the aqueous phase after 50 ml of 0.200 M Q is treated by extraction with the following quantities of n-hexane　：
  （a）　one 40 ml portion.
  （b）　two 20 ml portions.

（10%）16. Define the following terms for chromatography：
  （a）elution
  （b）stationary phase
  （c）retention time
  （d）partition ratio
  （e）selectivity factor