

臺灣綜合大學系統 109 學年度學士班轉學生聯合招生考試試題

科目名稱	微積分 A	類組代碼	共同考科
		科目碼	E0011

※本項考試依簡章規定所有考科均「不可」使用計算機。

本科試題共計 2 頁

答題時，請詳述計算過程，否則將不予計分。

1. (10 pts) Evaluate the following limits if they exist.

(a) $\lim_{n \rightarrow \infty} \frac{3n+2}{2n+1}$

(b) $\lim_{x \rightarrow 0} \frac{\cos(2x)-1}{x^2}$

2. (10 pts) A curve in \mathbb{R}^2 is given parametrically by

$$x = t^2 + 2t + 3$$

$$y = t^4 - 3t^3$$

for all $t > 0$. Find $\frac{dy}{dx}$ at the point $(6, -2)$.

3. (10 pts) Let $x > 0$ and $\triangle ABC$ be a triangle whose side lengths are $\overline{BC} = 5$, $\overline{AC} = 4$, $\overline{AB} = 3$.

Choose a point P on \overline{AB} , and a point Q on \overline{BC} , and a point R on \overline{AC} so that

$$\frac{\overline{BP}}{\overline{AP}} = \frac{\overline{CQ}}{\overline{BQ}} = \frac{\overline{AR}}{\overline{CR}} = x$$

Let $f(x)$ be the area of $\triangle PQR$. Find the critical point and the minimum of $f(x)$.

4. (10 pts) Find the radius of the convergence of the power series $\sum_{n=0}^{\infty} \frac{(2n)^n}{n!} x^n$.

5. (10 pts) Evaluate the improper integral

$$\int_0^{\frac{\pi}{2}} \cos x \left(\ln \cos \frac{x}{2} + \ln \sin \frac{x}{2} \right) dx$$

6. (10 pts) Let $g : (0, \infty) \rightarrow \mathbb{R}$ be a twice differentiable function. Assume that

$$g(1) = 1, g'(1) = 3, g''(1) = -4.$$

Define a real valued function h on $\mathbb{R}^3 \setminus \{(0, 0, 0)\}$ by

$$h(x, y, z) = g\left(\sqrt{x^2 + y^2 + z^2}\right)$$

Calculate $\frac{\partial^2 h}{\partial x^2}(P) + \frac{\partial^2 h}{\partial z^2}(P) + \frac{\partial^2 h}{\partial z^2}(P)$ where $P = \left(\frac{2}{3}, \frac{2}{3}, \frac{-1}{3}\right)$.

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7. (10 pts) Let S be the surface defined by the equation

$$x \cos(xy) + z^2 y^4 - 7xz = 1$$

and $P(0,1,1)$ be a point on S . Find an equation that defines the tangent plane to S at P and a parametric equation of the normal line to S at P .

8. (10 pts) Evaluate the double integral

$$\iint_R (y-x) dA$$

where $R = \{(x, y) \in \mathbb{R}^2 : 1 \leq x^2 + y^2 \leq 4, x \geq 0\}$.

9. (10 pts) Let C be the curve in \mathbb{R}^3 defined by the parametric equation

$$x(t) = \cos(t), y(t) = \sin(t), z(t) = t$$

for $0 \leq t \leq a$. Suppose that the arc length of C is $\frac{\sqrt{2}\pi}{4}$. Evaluate the line integral $\int_C \mathbf{F} \cdot d\mathbf{r}$ of the

vector field $\mathbf{F} = xz\mathbf{i} + yz\mathbf{j} + x^3\mathbf{k}$ on \mathbb{R}^3 .

10. (10 pts) Find the flux of the vector field \mathbf{F} on \mathbb{R}^3 defined by

$$\mathbf{F} = 3x\mathbf{i} + 2y\mathbf{j} + 5z\mathbf{k}$$

through the surface $S = \{(x, y, \sqrt{1-x^2-y^2}) \in \mathbb{R}^3 : x^2 + y^2 \leq 1\}$ oriented with upward pointing normal vector field.

備註： $\mathbf{i} = (1, 0, 0)$, $\mathbf{j} = (0, 1, 0)$, $\mathbf{k} = (0, 0, 1)$.

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科目名稱	普通物理 B	類組代碼	共同考科
		科目碼	E0015

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本科試題共計 三 頁

Some useful constants

Gas constant $R = 8.314 \text{ J/mol}\cdot\text{K}$

Gravitational constant $G = 6.68 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$

Mass of Sun $= 2.0 \times 10^{30} \text{ kg}$

Mass of Earth $= 6.0 \times 10^{24} \text{ kg}$

Radius of Earth $= 6.4 \times 10^6 \text{ m}$

Radius of Sun $= 7.0 \times 10^8 \text{ m}$

Electron mass $m_e = 9.1 \times 10^{-31} \text{ kg}$

Electron charge $e = 1.6 \times 10^{-19} \text{ C}$

Electric constant (permittivity) $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$

Magnetic constant (permeability) $\mu_0 = 4\pi \times 10^{-7} \text{ T}\cdot\text{m}/\text{A}$

Plank's constant $h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$

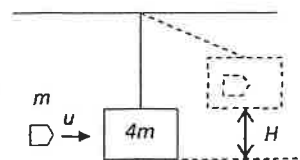
$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$

Boltzmann constant $k_b = 1.380 \times 10^{-23} \text{ J}\cdot\text{K}^{-1}$

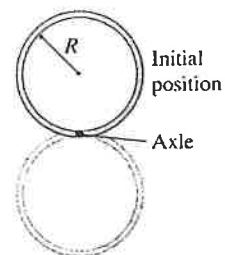
第一部分：填充簡答題（80 分）

共 16 題，每題 5 分，請於答案卷上依序作答並標明題號（無需詳列計算過程）。

- In a circular motion, the radius $r = 20 \text{ m}$, and the tangential speed $v = t^2 + 1$, where t is in unit s and v is in unit m/s. What are magnitudes of the instantaneous tangential acceleration and centripetal acceleration at $t=3 \text{ s}$?
- A car of mass m moves on a frictionless road. At $t = 0$, the driver shuts the engine off, and the car has speed v_0 . After that, the only force acting on the car is the air drag force: $\vec{F} = -Av\hat{v}$, where A is a constant, and \vec{v} is the velocity. For $t \geq 0$, find the speed of the car as a function time t .
- A bullet of mass m is fired into a suspended block of mass $4m$ with a speed u . The bullet then embeds in the block and raises the block. What is the maximum raised height H ?



- An object of mass m is initially at rest on a frictionless horizontal plane. If a constant power P acts on this object for t duration, how far will it travel during this interval?
- A thin ring of mass M and radius R rotates about an axis through its edge. The ring starts at its highest point and is given a very small push to start its rotation. What is the angular velocity at the lowest point?



- A uniform spherical planet has mass M and radius R . A very thin tunnel passes from one end of the planet, through the planet center, and then out from the other end of the planet. A particle of mass m fell into one end of the tunnel and then performed simple harmonic motion. Find the angular frequency of the simple harmonic motion.

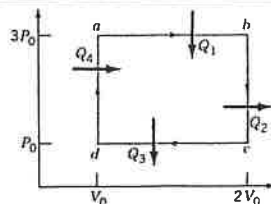
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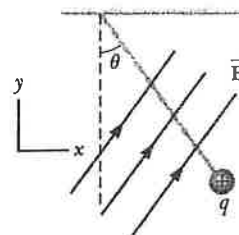
本科試題共計 三 頁

7. One mole of an ideal monatomic gas is taken around the reversible cycle as shown in the figure. Find the efficiency of the heat engine.



8. (True or False?) An *irreversible* engine works in cycles. When the engine returns to its initial state, the entropy change of the engine is zero.

9. A charged cork ball of mass m is suspended on a light string in the presence of a uniform electric field as shown in the right figure. When $E = A i + B j$, where A and B are positive quantities, the ball is in equilibrium at the angle θ . The tension in the string is _____.

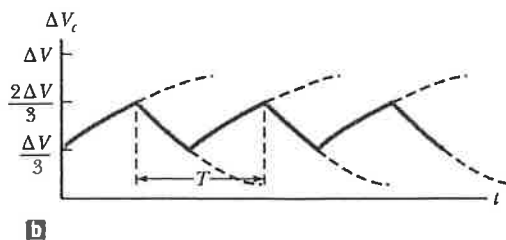
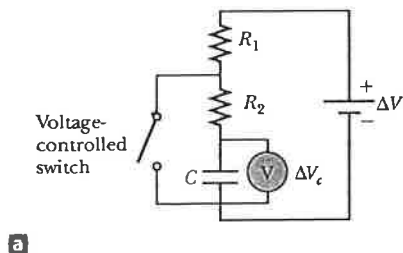


10. A solid insulating sphere of radius R has a nonuniform charge density that varies with r according to the expression $\rho = Ar^2$, where A is a constant and $r < R$ is measured from the center of the sphere. (a) Show that the magnitude of the electric field outside ($r > R$) the sphere is _____.

11. A particle with charge q is located at $x = 2R$, and a particle with charge $-2q$ is located at the origin. The equipotential surface that has zero potential is a sphere centered at $(-4R/3, 0, 0)$ and having a radius _____.

12. Consider two long, parallel, and oppositely charged wires of radius r with their centers separated by a distance D that is much larger than r . Assuming the charge is distributed uniformly on the surface of each wire, show that the capacitance per unit length of this pair of wires is _____.

13. The switch in the following figure a closes when $\Delta V_C > 2/3 \Delta V$ and opens when $\Delta V_C < 1/3 \Delta V$. The ideal voltmeter reads a potential difference as plotted in following figure b. What is the period T of the waveform in terms of R_1 , R_2 , and C ?



14. A bar of mass m and resistance R slides without friction in a horizontal plane, moving on parallel rails as shown in the following figure. The rails are separated by a distance d . A battery that maintains a constant emf \mathcal{E} is connected between the rails, and a constant magnetic field B is directed perpendicularly out of

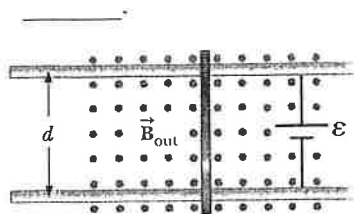
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the page. Assuming the bar starts from rest at time $t = 0$, show that at time t it moves with a speed



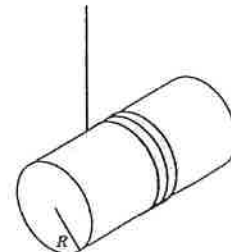
15. High-power lasers in factories are used to cut through cloth and metal. One such laser has a beam diameter of 1.00 mm and generates an electric field having an amplitude of 0.700 MV/m at the target. Find the power delivered by the laser.

16. The rest energy of a proton is 938 MeV, and the total energy of a proton is twice its rest energy. Find the momentum of the proton in MeV/c units, c is the speed of light.

第二部分：計算題（20分）

共 2 題，每題 10 分，請於答案卷上 **依序作答** 並 **標明題號**（中英文作答均可，需詳列計算過程）。

- A solid cylinder of mass M and radius R is rounded by a string.
 - If the solid cylinder unwinds on the vertical string without spinning, what is the tension of the string? (5 points)
 - If the string is pulled to have the cylinder spin but not fall, what is the angular acceleration of the cylinder? (5 points)



- A light source emitting radiation at frequency 7.00×10^{14} Hz is incapable of ejecting photoelectrons from a certain metal. In an attempt to use this source to eject photoelectrons from the metal, the source is given a velocity toward the metal.
 - When the speed of the light source is equal to $0.280 c$, photoelectrons just begin to be ejected from the metal. What is the work function of the metal? (5 points)
 - When the speed of the light source is increased to $0.900 c$, determine the maximum kinetic energy of the photoelectrons. (5 points)

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本科試題共計 4 頁

第壹部份：請於答案卡作答

I. 綜合測驗 40% (單選題、每題 2 分不倒扣)

1. I'm awfully sorry for the mistake. Please ___ my sincere apology.
(A) receive (B) expect (C) accept (D) excuse
2. The final proofs of the book have been sent to the ___ so that the book will be out by June.
(A) bookstore (B) library (C) laboratory (D) publisher
3. We have ___ an extra staff member since the outbreak to help with the News Center.
(A) recruited (B) reported (C) reduced (D) replaced
4. Ask your ___ about new advances that might help your cat live better.
(A) veteran (B) veterinarian (C) vegetarian (D) vendor
5. We must be careful about Grandpa's health condition because he has diabetes, a ___ disease that has troubled him for many years.
(A) chronic (B) terminal (C) genetic (D) fatal
6. In the United States, patients don't get their pills directly from their doctors; instead, they go to a pharmacy to have the ___ filled.
(A) presentation (B) prescription (C) perspiration (D) preparation
7. The store doesn't accept credit card, so I must go to the bank to ___ some money.
(A) deposit (B) install (C) withstand (D) withdraw
8. Ted has had two big cups of coffee since this morning, feeling extremely tired and ___ after a restless night.
(A) drunk (B) drowsy (C) cozy (D) dumb
9. For any employer, a valuable trait in an employee is whether he or she is ___.
(A) rebellious (B) renewable (C) repentant (D) reliable
10. Sometimes even kind people are ___ to help strangers for fear of being cheated.
(A) reluctant (B) eager (C) willing (D) hasty
11. Despite the serious damages brought by the rain, the mayor simply ___ the crisis instead of taking effective actions to minimize the negative impacts.
(A) shut her eyes to (B) closed access to (C) put the blame on (D) opened fire with
12. The two Taiwanese were finally put into jail after they had been ___ drugs and guns for years.
(A) addicted to (B) trafficking in (C) curious about (D) contributed to
13. Unlike most schoolboys, who are into outdoor sports, Thomas is very ___ cooking.
(A) interested in (B) poor at (C) indifferent to (D) nervous about
14. Keep the bottle ___ the children because it contains toxic substance.
(A) within the sight of (B) out of the reach of (C) beyond the control of (D) inside the room of
15. After seeing the dentist, Jane ___ and returned to work at noon.
(A) feels good (B) felt much better (C) was more better (D) is getting better
16. Do you have any idea ___?
(A) when will they arrive (B) if they've arrived (C) have they arrived (D) are they arrived
17. ___ Taiwanese studied in Europe several years ago.
(A) Not as many (B) Very little (C) More and more (D) As many as
18. In the past two weeks, ___ a fistfight and a robbery in the walkway near the elementary school.
(A) there are (B) there was (C) there have been (D) there have
19. I was absent from school last week. ___?
(A) I wonder if I can lend you my class notes.
(B) Do you mind borrowing me your class notes?
(C) May I lend your class notes?
(D) Will you lend me your class notes?
20. Which of the following sentences is error-free, based on standard written English?

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- (A) Canadian Prime Minister Trudeau went into a long silence before responding a journalist's question about President Trump's handling of George Floyd protests.
- (B) We suggested, at the meeting, that the government conduct a survey of the issue to find out about the residents' opinions.
- (C) Sarah finally decided to serve the ice cream to her guests that she had been keeping in the refrigerator.
- (D) To celebrate my sixtieth birthday, I have decided to buy me the red car the BMW dealer showed me the other day.

II. 克漏字 20% (單選題、每題 2 分不倒扣)

There are three kinds of outlines one may prepare for a speech: sentence outline, phrase outline and key-word outline. Among them, which is the most 21 effective speech delivery and why? Of course, the answers depend on factors such as audience expectations, the speaker's skills, and the amount of time allowed for the speech. In general, 22, it can be argued that a key-word outline is the best when presenting a speech because it provides prompts that allow a speaker to 23 memory lapses and at the same time does not hinder such delivery techniques as eye contact. Moreover, if a speaker is sufficiently 24 the content of the speech and does not need to read the outline, he or she will appear more credible to the audience, and this credibility will 25 itself in the delivery.

21. (A) vulnerable to (B) conducive to (C) liable to (D) accustomed to
22. (A) however (B) moreover (C) therefore (D) specifically
23. (A) extend (B) trace (C) avoid (D) promote
24. (A) familiar with (B) associated with (C) compatible with (D) contented with
25. (A) manifest (B) detect (C) develop (D) possess

Ubiquitous comes to us from the noun *ubiquity*, 26 "presence everywhere or in many places simultaneously." *Ubiquity* first appeared in print in the late 16th century, but *ubiquitous* didn't make an appearance 27 1830. (Another noun form, *ubiquitousness*, arrived around 1874.) Both words are ultimately 28 the Latin word for "everywhere," which is *ubique*. *Ubiquitous*, which has often been used with a touch of exaggeration for things and people that seem to 29 everywhere, has become a more widespread and popular word than *ubiquity*. It may not quite be ubiquitous, but if you keep your eyes and ears open, you're 30 encounter the word *ubiquitous* quite a bit.

26. (A) meaning (B) means (C) meant (D) whose meaning
27. (A) in (B) around (C) until (D) till
28. (A) derived from (B) independent of (C) consistent with (D) decided on
29. (A) turn up (B) take off (C) show off (D) drop out
30. (A) suspected to (B) used to (C) disinclined to (D) apt to

III. 閱讀測驗 20% (單選題、每題 2 分不倒扣)

At the very end of two days of looking at great art in Amsterdam, I came across a Pablo Picasso painting that made me laugh: "Seated Woman Wearing a Hat in the Shape of a Fish." The painting is in Amsterdam's modern art museum, the Stedelijk. The date is 1942, midway through the Second World War. I had to look up the artist's whereabouts during this time. As it happened, he stayed in Paris during the entire Nazi occupation. Naturally, the Gestapo regarded him as subversive—and he certainly was, though not in any way the Nazis could understand. He did not bother to exhibit his work at this time, but he never stopped creating.

According to one account, one day Gestapo officers were in his studio harassing him, as they often did. They spotted his great antiwar painting, "Guernica," which depicts the terrible suffering

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inflicted by German bombers on a town full of innocent victims during the Spanish Civil War. A Gestapo officer pointed at the painting, which was not yet acknowledged as one of the most powerful antiwar images ever made, and asked Picasso, "Did you do this?" "No," Picasso reportedly replied. "You did."

So what about this woman with a fish on her head? Could it be a spoof on military headgear? Or a joke about pompous officials in general? Was Picasso poking fun at some acquaintance? Was he making fun of women's frivolous fashions during wartime? I don't know. Maybe the painting means nothing at all—maybe that is the point. Maybe it is just meant to provoke a smile. In even the darkest times, we need artists who are able to show us that there is more to life than the grim reality that sometimes surrounds us.

31. Based on the reading above, when he was painting "Seated Woman Wearing a Hat in the Shape of a Fish," Picasso was in
(A) Amsterdam (B) Paris (C) Germany (D) Spain
32. What specific conclusion does the author make about "Seated Woman Wearing a Hat in the Shape of a Fish"?
(A) It expresses Picasso's most powerful antiwar feelings.
(B) It proves how subversive Picasso really is.
(C) It conveys Picasso's criticism about women's fashions.
(D) No definitive answer is given about what the painting is about.
33. According to the passage above, which of the following statements is correct?
(A) Picasso discontinued painting during wartime.
(B) Picasso avoided war-related content in his creation.
(C) Picasso was highly respected by the Gestapo.
(D) Picasso did not exhibit his paintings during Nazi occupation.
34. What would be a proper title of the reading above?
(A) "Paintings in the Stedelijk Modern Art Museum"
(B) "Subversive Artists in Wartime"
(C) "Seated Woman Wearing a Hat in the Shape of a Fish"
(D) "Nazi Rule and Gestapo Officers"

People have a grim fascination with shocking stories--and the more outrageous, the better. From gambling and gunmen to insider trading and infidelity, we find it difficult to turn away from a spectacle. The publishing industry has always appreciated the value of guilty pleasures, as has the news media. These books about the darker aspects of human life (and death) satisfy morbid curiosity, and many have become collectible.

With that in mind, while attempting to remain within the bounds of good taste, AbeBooks presents books and ephemera showcasing the notorious, infamous and scandalous. Enjoy!

First, let's talk about the true, undeniable criminals. Gangsters and bank robbers are romanticized and may bring to mind men with cigars, wearing pinstriped suits and shouting, "You'll never take me alive!" The reality, however, is less fanciful and much darker, and often leaves lost lives in its wake. Nobody seems to personify that image more than Clyde Barrow and Bonnie Parker, better known as Bonnie and Clyde, the infamous American depression-era outlaws. Their exploits have been told and re-told and hailed as a great love story, even resulting in a popular song, "The Ballad of Bonnie and Clyde" by English R&B singer Georgie Fame. In actuality, Bonnie and Clyde were responsible for the deaths of at least nine people during their spree. We have their wanted poster (with photographs of the duo) available for purchase. It was issued in 1934, two days before the pair were shot and killed by police. Want to learn more about Bonnie and Clyde? You can also find a copy of their biography as told by Bonnie's mother and Clyde's sister.

If you're a fan of mafia lore, and want a collectible piece of mob memorabilia, there's a cancelled

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check signed by Meyer Lansky, co-founder of the National Crime Syndicate, or an autograph by Al Capone himself.

More comfortable with fictional crime bosses? This first edition of *The Godfather*, signed by Mario Puzo, may be right up your alley.

Italy and the United States certainly haven't cornered the market on outlaws--Australia's Ned Kelly is celebrated by some folks as a national hero for his disobedience of 19th century colonial rule, and condemned by others as a no-good, illiterate thug and scofflaw. We have a true first of Peter Carey's interpretation of the Ned Kelly story, signed by the author. See *True History of the Kelly Gang*.

35. The passage above is taken from
 (A) a book review
 (B) an advertisement.
 (C) a history book.
 (D) a travel brochure
36. Who are the targeted readers of the passage, most likely?
 (A) crime story lovers
 (B) law-abiding citizens
 (C) infamous outlaws
 (D) police officers
37. One thing mentioned in the passage about the value of the books is that
 (A) they satisfy morbid curiosity.
 (B) they are easily readable.
 (C) they are reasonably priced.
 (D) they romanticize gangsters.
38. Based on what is mentioned in the passage, items that are available for sale include
 (A) Al Capone's autobiography.
 (B) Mario Puzo's pinstriped suit.
 (C) the biography of Bonnie and Clyde.
 (D) the photographs of Ned Kelly.
39. Which of the following about Bonnie and Clyde is incorrect?
 (A) Their exploits have been treated as a love story.
 (B) They were outlived by their families.
 (C) They lived during the period of the United States' economic downturn.
 (D) They were arrested in 1934 and shot by police two days later.
40. What does the passage say about people in general?
 (A) They are attracted to guilty pleasures.
 (B) They are guilty of gambling and insider trading.
 (C) They enjoy collecting useless weird stuff.
 (D) They always admire people of good taste.

第貳部份：請於答案卷作答

IV. 英文寫作 20%

To impress a foreign friend you met on the internet, write a short paragraph (between 120 and 150 words) about your home country. Tell your friend what you are most proud of about your country.