1. Determine the slope = \( \boxed{} \) of the graph of \( 3(x^2 + y^2)^2 = 100xy \) at the point \((3,1)\).

2. Find the extrema = \( \boxed{} \) of \( y = 3x^{2/3} - 2x \) on the interval \([-1,1]\).

3. Find two positive numbers = \( \boxed{} \) which satisfy that the sum of the first number squared and the second number is 54 and the product is a maximum.

4. Evaluate \( \int_0^6 |x^2 - 4x + 3| \, dx = \boxed{} \).

5. Evaluate \( \int \sqrt{x \sec^2 x} \, dx = \boxed{} \).

6. Find \( (f^{-1})'(a) = \boxed{} \) where \( f(x) = x^3 + 2x - 1 \) and \( a = 2 \).

7. Find the volume = \( \boxed{} \) of the solid generated by revolving the region bounded by the graphs of \( y = \frac{1}{x} \), \( y = 0 \), \( x = 1 \), and \( x = 3 \) about the \( x \)-axis.

8. Find the area = \( \boxed{} \) of the surface generated by revolving \( y = \sqrt{9 - x^2} \), \(-2 \leq x \leq 2\) about the \( x \)-axis.

9. Evaluate \( \int \frac{3x - 4}{(x - 1)^2} \, dx = \boxed{} \).

10. Evaluate \( \lim_{x \to 0} \frac{x}{\arctan 2x} = \boxed{} \).

11. Determine the convergence or divergence = \( \boxed{} \) of the series \( \sum_{n=1}^{\infty} \frac{1}{n!(n^2)} \).

12. Find the interval = \( \boxed{} \) of convergence of the power series \( \sum_{n=1}^{\infty} \frac{k(k + 1)(k + 2) \cdots (k + n - 1)x^n}{n!} \), \( k \geq 1 \).

13. Find the Maclaurin series = \( \boxed{} \) for the function \( f(x) = \frac{1}{\sqrt{1 - x}} \).

14. Find the arc length = \( \boxed{} \) of the curve \( x = t^2 + 1 \) and \( y = 4t^3 + 3 \), \(-1 \leq t \leq 0 \).

15. Find the area = \( \boxed{} \) of the common interior of \( r = 3 - 2\sin \theta \) and \( r = -3 + 2\sin \theta \).

16. Determine whether the statement is true or false = \( \boxed{} \). If two lines \( L_1 \) and \( L_2 \) are parallel to a plane \( P \), then \( L_1 \) and \( L \) are parallel.

17. Find the directional derivative = \( \boxed{} \) of \( g(x, y, z) = xyez \) at \( P(2, 4, 0) \) in the direction of \( Q(0, 0, 0) \).

18. Find the minimum value = \( \boxed{} \) of \( f(x, y) = \sqrt{x^2 + y^2} \) subject to the constraint \( 2x + 4y - 15 = 0 \).

19. Evaluate \( \int_0^2 \int_0^{\sqrt{4-x^2}} \sin \sqrt{x^2 + y^2} \, dy \, dx = \boxed{} \).

20. Find the volume = \( \boxed{} \) of the solid bounded above \( z = 2x \) and below by \( z = 2x^2 + 2y^2 \).
選擇題 60%（單選，每題5分，答錯不倒扣）
1. A car travels 40 kilometers at an average speed of 80 km/h and then travels 40 kilometers at an average speed of 40 km/h. The average speed of the car for this 80 km trip is: (a) 40 km/h (b) 45 km/h (c) 48 km/h (d) 53 km/h (e) 80 km/h.
2. A racing car traveling with constant acceleration increases its speed from 10 m/s to 30 m/s over a distance of 80 m. How long does this take? (a) 2.0 s (b) 4.0 s (c) 5.0 s (d) 8.0 s (e) The time cannot be calculated since the speed is not constant.
3. A ball is thrown horizontally from the top of a 20-m high hill. It strikes the ground at an angle of 45°. With what speed was it thrown? (The gravitational acceleration constant \( g=9.8 \text{ m/s}^2 \)) (a) 14.2 m/s (b) 19.8 m/s (c) 28.6 m/s (d) 32.4 m/s (e) 40 m/s.

4. A 90-kg man stands in an elevator that has a downward acceleration of 1.4 m/s². The force exerted by him on the floor is about: (The gravitational acceleration constant \( g=9.8 \text{ m/s}^2 \)) (a) zero (b) 90 N (c) 756 N (d) 882 N (e) 1008 N.
5. A 12-kg crate rests on a horizontal surface and a boy pulls on it with a force that is 30° below the horizontal. If the coefficient of static friction is 0.40, the minimum magnitude force he needs to start the crate moving is: (a) 44 N (b) 47 N (c) 54 N (d) 56 N (e) 71 N.
6. A 0.50-kg block attached to an ideal spring with a spring constant of 80 N/m oscillates on a horizontal frictionless surface. The total mechanical energy is 0.12 J. The greatest extension of the spring from its equilibrium length is: (a) 1.5 \times 10^{-3} \text{ m} (b) 3.0 \times 10^{-3} \text{ m} (c) 0.039 \text{ m} (d) 0.054 \text{ m} (e) 18 \text{ m}.
7. A 0.20-kg particle moves along the x axis under the influence of a stationary object. The potential energy is given by \( U(x) = (8.0J/m^2)x^2 + (2.0J/m^4)x^4 \), where \( x \) is in coordinate of the particle. If the particle has a speed of 5.0 m/s when it is at \( x = 1.0 \text{ m} \), its speed when it is at the origin is: (a) 0 (b) 2.5 m/s (c) 5.7 m/s (d) 7.9 m/s (e) 11 m/s.
8. The pull \( P \) is just sufficient to keep the 14-N block and the weightless pulleys in equilibrium as shown. The tension \( T \) in the upper cable is: (a) 14 N (b) 28 N (c) 16 N (d) 9.33 N (e) 18.7 N.

9. A Carnot engine operates between 200°C and 20°C. Its maximum possible efficiency is: (a) 90% (b) 100% (c) 38% (d) 72% (e) 24%.
10. A plane parallel plate capacitor has plates of 10 cm² area that are 1.0 mm apart. At an instant when charge is being accumulated on the plates at a rate of 12 nC/s, the displacement current between the plates is: (a) 1.06\times10^{-16} \text{ A} (b)1.2\times10^{-8} \text{ A} (c)8.85\times10^{-9} \text{ A} (d)6.66\times10^{-16} \text{ A} (e)4.62\times10^{-8} \text{ A}.
11. If \( a = 1.0 \) cm, \( b = 3.0 \) cm, and \( I = 30 \) A, what is the magnitude of the magnetic field at point \( P \)? (Permeability of free space \( \mu_0 = 4\pi \times 10^{-7} \) T\( \cdot \)m/A) (a) 0.62 mT (b) 0.59 mT (c) 0.35 mT (d) 0.31 mT (e) 0.10 mT.

12. The phase difference between the two waves which give rise to a dark spot in a Young's double-slit experiment is (where \( m = \) integer): (a) zero (b) \( 2\pi m + \pi /8 \) (c) \( 2\pi m + \pi /4 \) (d) \( 2\pi m + \pi /2 \) (e) \( 2\pi m + \pi \).

非選擇題 (40%)

1. A solid cube of wood of side \( 2a \) and mass \( M \) is resting on a horizontal surface. The cube is constrained to rotate about a fixed axis AB (Fig. P1). A bullet of mass \( m \) and speed \( v \) is shot at the face opposite ABCD at a height of \( 4a/3 \). The bullet becomes embedded in the cube. (a) Please show that the rotational momentum inertia of cube along one of its edge is \( 8Ma^2/3 \). (10 分) (b) Find the minimum value of \( v \) required to tip the cube so that it falls on face ABCD. (10 分) Assume \( m << M \).

2. A conducting bar of length \( \ell \) moves to the right on two frictionless rails as shown in Fig. P2. A uniform magnetic field directed into the page has a magnitude of 0.3 T. Assume \( R = 9.00\Omega \) and \( \ell = 0.35m \) (a) At what constant speed should the bar move to produce an 8.50 mA current in the resistor? (7 分) (b) What is the direction of the induced current? (6 分) (c) At what rate is energy delivered to the resistor? (7 分)