請依序作答。選擇題部份將題號與答案抄寫於答案卷上

一、選擇題（40%，單選，答錯不倒扣）

1. A 4-kg cart starts up an incline with a speed of 3 m/s and comes to rest 2 m up the incline. The total work done on the cart is: (a) 6 J  (b) 8 J  (c) 12 (d) 18 J  (e) not enough information given

2. An elevator is rising at constant speed. Consider the following statements: 
   I. the upward cable force is constant 
   II. the kinetic energy of the elevator is constant 
   III. the gravitational potential energy of the earth-elevator system is constant 
   IV. the acceleration of the elevator is zero 
   V. the mechanical energy of the earth-elevator system is constant 
   (a) all five are true  (b) only II and V are true  (c) only I, II, and III are true (d) only IV and V are true (e) only I, II, and IV are true

3. A 60-kg man is riding in a 20-kg cart at 2.0 m/s. He jumps off in such a way as to land on the ground with no horizontal velocity. The resulting change in speed of the cart is: (a) zero  (b) 2.0 m/s  (c) 4.0 m/s  (d) 6.0 m/s  (e) 8.0 m/s

4. A yo-yo, arranged as shown, rests on a frictionless surface. When a force \( F \) is applied to the string as shown, the yo-yo:

   \[
   \text{(a) moves to the left and rotates counterclockwise } \quad \text{ (b) moves to the right and rotates counterclockwise } \quad \text{ (c) moves to the right and rotates clockwise } \quad \text{ (d) moves to the left and rotates clockwise } \quad \text{ (e) moves to the right and does not rotate}
   \]

5. A large water tank, open at the top, has a small hole in the bottom. When the water level is 20 m above the bottom of the tank, the speed of the water leaking from the hole: 
   (a) is 5 m/s  (b) is 10 m/s  (c) is 20 m/s  (d) cannot be calculated unless the area of the hole is given  (e) cannot be calculated unless the areas of the hole and tank are given

6. A 5-cm radius conducting sphere has a charge density of \( 2 \times 10^{-6} \text{ C/m}^2 \) on its surface. Its electric potential, relative to the potential far away, is: (a) \( 1.1 \times 10^4 \text{ V} \)  (b) \( 2.2 \times 10^4 \text{ V} \)  (c) \( 2.3 \times 10^5 \text{ V} \)  (d) \( 3.6 \times 10^5 \text{ V} \)  (e) \( 7.2 \times 10^6 \text{ V} \)
7. The four wire loops shown move with the same speed into a region of uniform magnetic field \( B \), directed out of the page. Rank them according to the maximum magnitude of the induced emf, least to greatest.

(a) 3 and 4 tie, then 1 and 2 tie  (b) 1, 2, 3, 4  (c) 1 and 2 tie, then 3 and 4 tie  (d) 4, 2 and 3 tie, then 1  (e) 4, 2, 3, 1

8. It is better to send 10,000 kW of electric power long distances at 10,000 V rather than at 110 V because: (a) there is less heating in the transmission wires  (b) the resistance of the wires is less at high voltages  (c) more current is transmitted at high voltages  (d) the insulation is more effective at high voltages  (e) the "IR" drop along the wires is greater at high voltage

9. In order to obtain a good single-slit diffraction pattern for light with wavelength \( \lambda \), the slit width could be:  (a) \( \lambda \)  (b) \( 10 \lambda \)  (c) \( \lambda / 10 \)  (d) \( 10^2 \lambda \)  (e) \( \lambda / 10^3 \)

10. Light with an intensity of 1 MW/m\(^2\) falls normally on a surface with an area of 1 cm\(^2\) and is completely absorbed. The force of the radiation on the surface is: (a) 1.0x10\(^{-3}\) N  (b) 3.3x10\(^{-8}\) N  (c) 1.7x10\(^{-7}\) N  (d) 3.3x10\(^{-7}\) N  (e) 6.7x10\(^{-7}\) N

二、計算問答題

11. (10 %) 如下圖，A、B 兩物以細繩相接且質量均為 10 公斤，設滑輪甚輕且甚光滑，

(a) 若 A, B 與其接觸面皆無摩擦力，試求此時繩子的張力 \( T_1 \) 及 A 物由靜止出發，沿斜面下滑 1 公尺所需的時間 \( t_1 \)。

(b) 若 A 和 B 與其接觸面的靜摩擦係數皆為 0.2，動摩擦係數皆為 0.1，試求此時繩子的張力 \( T_2 \) 及 A 物由靜止出發，沿斜面下滑 1 公尺所需的時間 \( t_2 \)。
12. （10 %）有一梯子長為 2m，傾靠在光滑的牆上，梯子與地面夾角為 60°，梯子與地面間的靜摩擦係數為 0.5，則質量為 60 Kg 的人可爬至距梯底多遠處而梯子仍不致滑倒？（設梯子之質量可忽略）

13. （15 %）彈性係數為 k 的彈簧一端固定於壁上，另一端水平地連接質量為 M 的物體上，該物體位於光滑桌面上，今施力拉物體使彈簧伸長 L 後釋放，物體將有簡諧振動
(a) 若彈簧質量近於零，在某瞬間物體速度為 v，則彈簧所具位能為若干？
(b) 若彈簧質量為 m，某一瞬間物體速度為 v，則彈簧所具動能若干？
(c) 續 (b)，此時物體的振動週期為何？

14. （5 %）試比較熱量傳遞可能的機制及其差異性。

15. （10 %）長度同為 L 且對齊的三個同軸心金屬圓管 A, B, C，半徑分別為 R_a, R_b, 及 R_c (R_a < R_b < R_c << L)，各圓管間相互絕緣可形成電容器，
(a) 若各圓管間皆填充空氣，試求圓管 A, C 間的電容量為何？
(b) 若圓管 A, B 間填充了介電常數為 k 的絕緣物質，圓管 B, C 間填充空氣，試求圓管 A, C 間的電容量為何？

16. （10 %）某電磁波在真空中傳播，其電場 \( \vec{E}(x,y,z,t) \) 在空間 (x,y,z) (單位為公尺) 處，隨時間 t (sec) 的變化關係可表為

\[
\vec{E}(x,y,z,t) = (1,1,2) \exp \left\{ i \ 2\pi \left[ 10^5 \times (x + 2y - 2z) - ft \right] \right\} \quad \text{(V/m)}
\]

式中，i 為虛數符號，f 為頻率。試求 (a) 此電磁波的前進方向為何? (b) 此電磁波的波長為多少公尺？