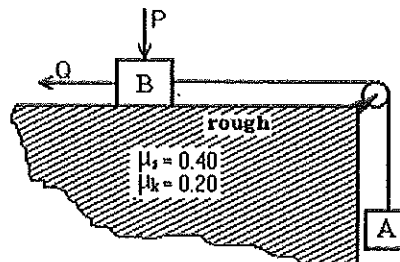


(一) 選擇題 (50%)

1. Two bullets are fired simultaneously at the same height and parallel to a horizontal plane. The bullets have different masses and different initial velocities. Which one will strike the plane first? (5%)

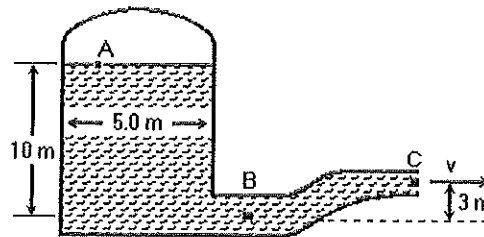
- A) The fastest one.
- B) The slowest one.
- C) The heaviest one.
- D) The lightest one.
- E) They strike the plane at the same time.

2. Blocks A and B of masses 9 kg and 14 kg, respectively, are connected by a rope, which passes over a light frictionless pulley, as shown below. The horizontal surface is rough. The coefficients of static and kinetic friction are 0.40 and 0.20, respectively. External forces P and Q act on block B, as shown. In Figure below, force P equals 56 N. The maximum value of force Q, for which the system remains at rest is closest to: (5%)

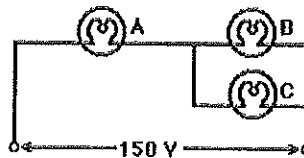


- A) 120 N
- B) 130 N
- C) 150 N
- D) 170 N
- E) 180 N

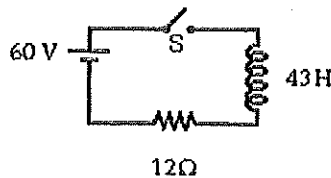
3. A pressurized cylindrical tank, 5.0 m in diameter, contains water which emerges from the pipe at point C, with a velocity of 20 m/s. Point A is 10 m above point B and point C is 3 m above point B. The area of the pipe at point B is 0.09m^2 and the pipe narrows to an area of 0.04m^2 at point C. Assume the water is an ideal fluid in laminar flow. The density of water is 1000kg/m^3 . In Figure below, the mass flow rate in the pipe is closest to: (5%)



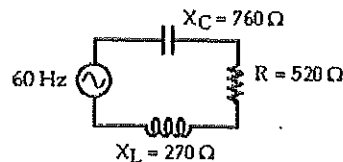
- A) 900 Kg/s
B) 800 Kg/s
C) 720 Kg/s
D) 640 Kg/s
E) 560 Kg/s
4. A Carnot engine operating between a warmer unknown temperature and a reservoir of boiling helium at 1.76 K has an efficiency of 14.0%. What is the warmer temperature? (5%)
- A) 0.130 K
B) 0.140 K
C) 151 K
D) 9.2 K
E) 2.05 K
5. Three light bulbs, A, B, and C, have electrical ratings as follows:
- Bulb A - 85 W, 1.1 A
Bulb B - 80 V, 205 W
Bulb C - 120 V, 0.9 A
- The three bulbs are connected in a circuit, which is across a 150-V line, as shown next page. Assume the filament resistances of the light bulbs are constant and independent of operating conditions. In Figure next page, the equivalent resistance of the circuit is closest to: (5%)



- A) 76Ω
 B) 96Ω
 C) 110Ω
 D) 130Ω
 E) 150Ω
6. An R-L circuit has a 60 V battery, a 43 H inductor, a 12 ohm resistor, and a switch S, in series, as shown below. Initially, the switch is open, and there is no magnetic flux in the inductor. At time $t = 0$ sec, the switch is closed. In Figure below, when the time $t = 0.358$ sec, the current in the circuit is closest to: (5%)

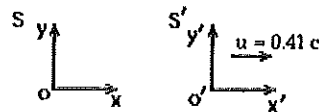


- A) 0.32 A
 B) 0.40 A
 C) 0.48 A
 D) 2.7 A
 E) 5.0 A
7. The 60 Hz ac source of a series circuit has a voltage amplitude of 120 V. The capacitive and inductive reactances are 760Ω and 270Ω , respectively. The resistance is 520Ω . In Figure below, the rms current in the circuit is closest to: (5%)

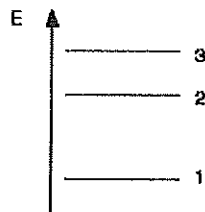


- A) 0.12 A
 B) 0.13 A
 C) 0.14 A
 D) 0.15 A
 E) None of the above answers are correct.

8. System S' has a velocity $u = +0.41c$ relative to system S , as shown below. The clocks of S and S' are synchronized at $t = t' = 0$ sec when the origins O and O' coincide. An event is observed in both systems. The event takes place at $x = 900$ m and at time $t = 6.0 \mu\text{s}$, as measured by an observer in S . In Figure below, the time t' of the event, measured by an observer in S' is closest to: (5%)



- A) $5.0 \mu\text{s}$
 B) $5.2 \mu\text{s}$
 C) $4.4 \mu\text{s}$
 D) $4.8 \mu\text{s}$
 E) None of the above answers are correct.
9. Part of the energy level diagram of a certain atom is shown in Figure below. The energy spacing between levels 1 and 2 is twice that between 2 and 3. If an electron makes a transition from level 3 to level 2, the radiation of wavelength λ is emitted.



- What possible radiation wavelengths might be produced by other transitions between the three energy levels? (5%)
- A) Both $\lambda/2$ and $\lambda/3$
 B) Only $\lambda/2$
 C) Both 2λ and 3λ
 D) Only 2λ
 E) None of the above answers are correct.
10. How much energy is released when $1.000 \mu\text{g}$ of ${}^3\text{H}$ have decayed to ${}^3\text{He}$? Use $1 \text{ u} = 931.494 \text{ MeV}/c^2$, $M({}^3\text{He}) = 3.01493 \text{ u}$, and $M({}^3\text{H}) = 3.01550 \text{ u}$. (5%)
- A) $8.53 \times 10^3 \text{ J}$
 B) $5.69 \times 10^3 \text{ J}$
 C) $5.12 \times 10^4 \text{ J}$
 D) $1.71 \times 10^4 \text{ J}$
 E) None of the above answers are correct.

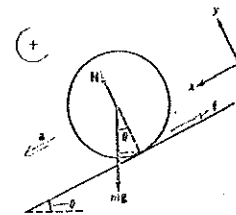
(二) 問答題 (20%)

1. State the four Maxwell's equations. (8%)
2. Carnot cycle is very important in thermodynamics. Draw the four thermal processes of the Carnot cycle in the P-V diagrams and the equations that satisfy the four processes respectively. (8%)
3. What is the general form of the equation and solution for harmonic oscillation? (4%)

(三) 計算題 (30%)

1. (15%) A disk with mass m and radius R rolls without slipping down an incline (shown in the figure on the right).
 - (A) Write down the Newton's equation of linear motion
 - (B) Write down the equation of rotational motion.
 - (C) What is the relation between the acceleration a and angular acceleration α ?
 - (D) Find the linear acceleration of the CM.

Note: $I = (1/2) MR^2$



2. (15%) A rail with a bar is inside a uniform magnetic B as shown in figure on the right. The bar with mass m is pulling by an external force F_{ext} in order to keep a constant velocity v moving to the right when it is released at $t = 0$.
 - (A) Find the induced current I going through the bar.
 - (B) Find the external force F_{ext} . (magnitude and direction).

