國立中山大學113學年度
碩士班暨碩士在職專班招生考試試題

科目名稱：普通物理【物理系碩士班】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- 試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。
- 試題採雙面列印，考生應注意試題頁數確實作答。
- 違規者依本校招生考試試場規則及違規處理辦法處理。

國立中山大學113學年度碩士班暨碩士在職專班招生考試試題

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※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（選擇題）　　

Single-choice questions: (20 questions in total, 5 points each)

1. Given a circuit in Fig. 1, which is composed of a battery of voltage V, six resistors of resistance R, and a voltmeter, what is the readout from the voltmeter?

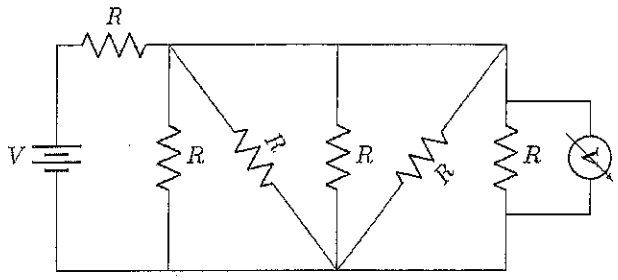

Figure 1: A circuit composed of a battery, six identical resistors, and a voltmeter.

(A) $\frac{5V}{6}$
(B) $\frac{2V}{3}$
(C) $\frac{V}{2}$
(D) $\frac{V}{3}$
(E) $\frac{V}{6}$

2. It is known that all mechanical quantities, including the universal constants G, c and $\hbar$, can be expressed in terms of length, time, and mass. In SI units, where the base of unit of length is meter (m), time is second (s), and mass is kilogram (kg), the three universal constants are $G = 6.67 \times 10^{-11}\ \mathrm{m^3 \cdot s^2 \cdot kg^{-1}}$, $c = 3.00 \times 10^{8}\ \mathrm{m \cdot s^{-1}}$, and $\hbar = 1.05 \times 10^{-34}\ \mathrm{m^2 \cdot s^{-1} \cdot kg}$. In another unit system, the base units of length, time, and, mass are denoted as ℓ_p, t_p, and m_p, respectively, so that $G = 1\,\ell^3 \cdot t_\mathrm{p}^{-2} \cdot m_\mathrm{p}^{-1}$, $c = 1\,\ell_\mathrm{p} \cdot t_\mathrm{p}^{-1}$, and $\hbar = 1\,\ell_\mathrm{p}^2 \cdot t_\mathrm{p}^{-1} \cdot m_\mathrm{p}$. What is ℓ_p in SI units?
(A) 1.61×10^{-35} m
(B) 2.18×10^{-8} m
(C) 5.39×10^{-44} m
(D) 1.42×10^{32} m
(E) 7.30×10^{-3} m

3. A sound source emits a sound wave of frequency f. If the source is moving toward a stationary observer at one third (i.e., 1/3) of the speed of sound, what frequency does the observer observe?
(A) $3f$
(B) $\frac{3f}{2}$
(C) f
(D) $\frac{2f}{3}$
(E) $\frac{f}{3}$

4. A string with two ends fixed has 12 Hz, 30 Hz, 33 Hz, and 45 Hz as harmonic frequencies. Which of the following is a possible fundamental frequency (first harmonic) of the string?
   (A) 2 Hz
   (B) 3 Hz
   (C) 5 Hz
   (D) 12 Hz
   (E) 18 Hz

5. Two blocks with masses m_A and m_B are attached to two identical springs. The block with mass m_A oscillates with amplitude A_A and frequency f_A, while the block with mass m_B oscillates with amplitude A_B and frequency f_B. What is the ratio between m_A and m_B, i.e., $\frac{m_A}{m_B}$?
   (A) $\frac{A_A f_A}{A_B f_B}$
   (B) $\frac{f_A}{f_B}$
   (C) $\frac{A_B f_A}{A_A f_B}$
   (D) $\frac{f_B^2}{f_A^2}$
   (E) $\frac{A_A f_B}{A_B f_A}$

6. Two 5-kg objects with velocities $\vec{v}_1 = 2\hat{e}_x + 3\hat{e}_y$ and $\vec{v}_2 = 2\hat{e}_x + 5\hat{e}_y$ in the unit of m/s collide and stick together. How much energy is lost in the process?
   (A) 5 J
   (B) 24 J
   (C) 78 J
   (D) 132 J
   (E) 247 J

7. On July 16, 1945, in the Manhattan Project led by Robert Oppenheimer, a physicist named Richard Feynman was observing the nuclear test. After the bomb was detonated (引爆), Feynman saw the flash of the bomb explosion roughly 40 seconds before he heard the sound of the explosion. Given the speed of light is 3.0×10^8 m/s and the speed of sound is 3.4×10^2 m/s, estimate the distance between Feynman and the place of detonation.
   (A) 1.6 km
   (B) 1.4×10 km
   (C) 3.1×10^2 km
   (D) 7.0×10^2 km
   (E) 1.2×10^7 km

8. According to the second law of thermodynamics, which of the statements below is **correct**?
   (A) Heat can never pass from a colder to a warmer body.
   (B) Heat cannot be converted into work.
   (C) Heat can flow spontaneously from hotter to colder regions.
   (D) It is derived from the first law of thermodynamics.
   (E) The entropy of a closed system always remains unchanged.

9. Two identical satellites, A and B, are circling around Earth in circular orbits. Given the orbital radius of A is twice that of B, what is the ratio of the speed of A to the speed of B?
   (A) 1
   (B) $\sqrt{2}$
   (C) $1/\sqrt{2}$
   (D) 2
   (E) 1/2

10. If the period of a simple pendulum on Earth is T what would be the period of the same pendulum on the Moon, where the gravitational acceleration is 1/6 of that on Earth?
   (A) $\sqrt{6}T$
   (B) $\sqrt{3}T$
   (C) T
   (D) $T/\sqrt{3}$
   (E) $T/\sqrt{6}$

11. Two spherical shells, A and B, surround an isolated charged point particle. Given that the radius of shell A is twice that of the radius of shell B, what is the ratio between the electric flux through shell A and the electric flux through shell B?
   (A) 4
   (B) 2
   (C) 1
   (D) 1/2
   (E) 1/4

12. A thin hoop rolls without sliding on a level surface (see Fig. 2). What is the ratio between the rotational energy and the translational energy?

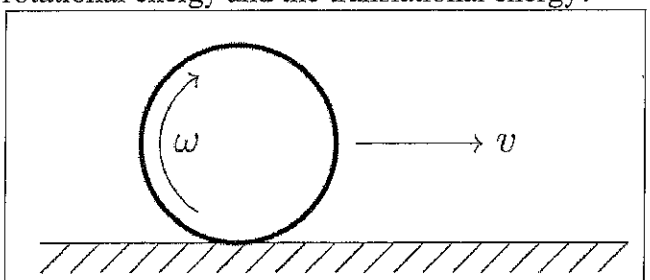

Figure 2: A hoop rolls on a level surface.

   (A) 2
   (B) $\sqrt{2}$
   (C) 1
   (D) $1/\sqrt{2}$
   (E) 1/2

13. A combination of pulleys is shown in Fig. 3, where a weight of mass m_1 is hung on the leftmost pulley, and a weight of mass m_2 is attached to the right end of the string. What is m_2 in terms of m_1 so that the system is in equilibrium?

(A) m_1
(B) $m_1/2$
(C) $m_1/3$
(D) $m_1/8$
(E) $m_1/16$

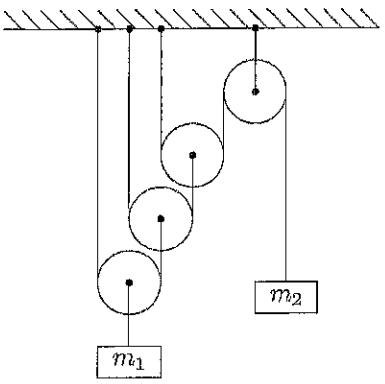

Figure 3: A combination of pulleys.

14. The heat capacities of objects A, B, and C are C_A , $C_B = 2C_A$, and $C_C = 3C_A$, respectively. If the temperatures of objects A, B, and C are 60°C, 30°C, and 20°C, what is the equilibrium temperature after objects A, B, and C are in touch?
(A) 30°C
(B) 35°C
(C) 40°C
(D) 45°C
(E) 50°C

15. About two-thirds of a solid wooden ball of density 0.53 g/ml is floating in an unknown liquid. Which of the following liquids could be the unknown liquid?
(A) Ethyl alcohol (density 7.89×10^2 kg/m^3)
(B) Water (density 1.00×10^3 kg/m^3)
(C) Mercury (density 1.36×10^4 kg/m^3)
(D) Hexane (density 6.54×10^2 kg/m^3)
(E) Olive oil (density 9.11×10^2 kg/m^3)

16. A rocket weighs 1.7×10^6 kg, where 80% of it is the fuel, and exhausts fuel with a relative speed of 2000 m/s. If the rocket is initially at rest in space, what is its speed after consuming all the fuel?
(A) 1.0×10^4 m/s
(B) 2.5×10^3 m/s
(C) 3.2×10^3 m/s
(D) 1.6×10^3 m/s
(E) 4.0×10^2 m/s

17. A coil with a constant cross-section $\vec{A}$ is moving with velocity $\vec{v}$ in a constant and uniform magnetic field $\vec{B}$. What is the voltage in the coil generated by the magnet?
(A) $\vec{B} \cdot \vec{A}|\vec{v}|$
(B) $\vec{B} \cdot \vec{v}|\vec{A}|$
(C) 0
(D) $|\vec{B} \cdot \vec{v}|/|\vec{A}|$
(E) $|\vec{A}||\vec{B}||\vec{v}|$

18. How much work is done by an ideal gas in an isothermal expansion from volume V_i to V_f? (Let n be the amount of the gas, R be the gas constant, and T be the absolute temperature.)
(A) $nRT(V_f - V_i)$
(B) $nRT\frac{V_f+V_i}{V_i}$
(C) $nRT\ln\frac{V_f+V_i}{V_f}$
(D) $nRT\ln\frac{V_f+V_i}{V_f-V_i}$
(E) $nRT\ln\frac{V_f}{V_i}$

19. A block of mass m_1 is stacked on top of another block of mass m_2 and attached via a massless string (see Fig. 4). The coefficient of static friction between the blocks is μ_B, and the coefficient of static friction between the block and the surface is μ_S. The pullies are massless and frictionless. What is the maximal mass W of a weight attached to the bottom block that still makes the system stationary?

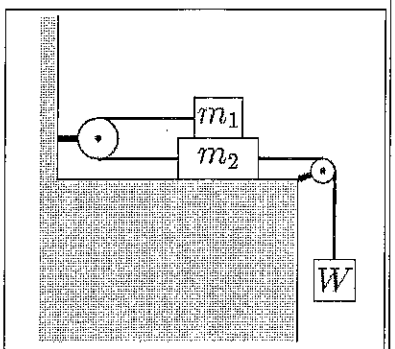

Figure 4: A stack of blocks.

(A) $m_1\mu_B + (m_1 + m_2)\mu_S$
(B) $2m_1\mu_B + (m_1 + m_2)\mu_S$
(C) $(m_1 + m_2)\mu_S$
(D) $-2m_1\mu_B + (m_1 + m_2)\mu_S$
(E) $m_1\mu_B + m_2\mu_S$

20. After heating a metal annular disc with inner radius r_i and outer radius r_o (see Fig. 5), which of the following statements is **not** true?

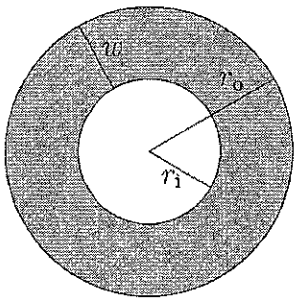

Figure 5: An annular disc with inner radius r_i and outer radius r_o.

(A) The outer radius r_o increases.
(B) The inner radius r_i increases.
(C) The total area of the annular disc increases.
(D) The width w, where $w = r_o - r_i$, of the annular disc remains the same.
(E) The sum of the areas of the annular disc and the hole increases.