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# AP Physics C: Mechanics Practice Paper 1

Full Exam Simulation — Calculus-Based Mechanics

**Section I: 35 multiple-choice (A–D) · Section II: 3 free-response questions (15 marks each) · 80 marks in all · 90 minutes**

## How to use this booklet

- Working time – 90 minutes (Section I: 45 minutes; Section II: 45 minutes). A scientific or graphing calculator is permitted throughout.
- Section I has 35 multiple-choice questions with four options (A–D). Section II has 3 free-response questions worth 15 marks each — show all work.
- An equation sheet is provided at the back of the question paper. Calculus (differentiation and integration) is expected.
- Worked solutions follow the paper: every question has step-by-step working, a key takeaway and (for multiple choice) a note on why each wrong option is wrong.

## SECTION I — MULTIPLE CHOICE

35 marks · 45 minutes · Attempt Questions 1 – 35

Choose the best answer for each question. Each question is worth 1 mark; there is no penalty for incorrect answers. A calculator and the equation sheet at the back are permitted.

**1. A 0.40 kg object moving at  $7.0 \text{ m s}^{-1}$  is struck by a force that acts along its direction of motion for 0.27 s. The force varies as  $F(t) = 79.0 \sin(\pi t/T)$  newtons, where  $T = 0.27 \text{ s}$ . What is the speed of the object just after the force stops?**

- A  $-26.9 \text{ m s}^{-1}$
- B  $20.6 \text{ m s}^{-1}$
- C  $33.9 \text{ m s}^{-1}$
- D  $40.9 \text{ m s}^{-1}$

**2. A particle moves along the x-axis with position  $x(t) = 0.600t^3 - 5.70t^2 + 7.70t$ , where x is in metres and t is in seconds. What is the particle's acceleration at  $t = 3.5 \text{ s}$ ?**

- A  $1.20 \text{ m s}^{-2}$
- B  $3.60 \text{ m s}^{-2}$
- C  $4.20 \text{ m s}^{-2}$
- D  $-2.90 \text{ m s}^{-2}$

**3. An object falls through a viscous fluid with a drag force proportional to its speed. As it approaches terminal speed, its acceleration:**

- A increases without bound
- B approaches zero
- C becomes negative
- D approaches g

**4. The period of a mass–spring oscillator is T. If the mass is increased by a factor of 4, the new period is:**

- A 16T
- B  $T/2$
- C 2T
- D 4T

5. A 1.1 kg block hangs from a light string wrapped around a uniform solid disk of mass 1.6 kg and radius 0.26 m that is free to rotate about its horizontal axle. The block is released from rest and falls 2.5 m. What is the angular speed of the disk at that moment?

- A  $5.33 \text{ rad s}^{-1}$
- B  $20.5 \text{ rad s}^{-1}$
- C  $78.8 \text{ rad s}^{-1}$
- D  $1.38 \text{ rad s}^{-1}$

6. A 1.6 kg bob on a string of length 0.60 m moves in a horizontal circle (a conical pendulum) with the string making an angle of  $35^\circ$  with the vertical. Take  $g = 9.8 \text{ m s}^{-2}$ . What is the period of the circular motion?

- A 0.224 s
- B 1.18 s
- C 1.41 s
- D 1.55 s

7. A 2.4 kg object is released from rest and falls in a fluid that exerts a drag force of magnitude  $bv$ , where  $b = 7.9 \text{ kg s}^{-1}$  and  $v$  is the speed. Take  $g = 9.8 \text{ m s}^{-2}$ . What is the speed 0.60 s after release?

- A  $5.88 \text{ m s}^{-1}$
- B  $0.496 \text{ m s}^{-1}$
- C  $2.56 \text{ m s}^{-1}$
- D  $0.413 \text{ m s}^{-1}$

8. A thin rod of length 3.2 m lies along the x-axis from  $x = 0$  to  $x = 3.2 \text{ m}$ . Its linear mass density is  $\lambda(x) = 2.2 (x/3.2)^2 \text{ kg m}^{-1}$ . How far is the centre of mass from the  $x = 0$  end?

- A 1.60 m
- B 2.13 m
- C 1.92 m
- D 2.40 m

## WORKED SOLUTIONS

Answers & worked solutions

### Multiple-choice answer key

|    |   |    |   |    |   |    |   |    |   |    |   |
|----|---|----|---|----|---|----|---|----|---|----|---|
| 1  | D | 2  | A | 3  | B | 4  | C | 5  | B | 6  | C |
| 7  | C | 8  | D | 9  | A | 10 | A | 11 | D | 12 | D |
| 13 | C | 14 | A | 15 | D | 16 | B | 17 | C | 18 | B |
| 19 | B | 20 | C | 21 | B | 22 | D | 23 | B | 24 | B |
| 25 | A | 26 | A | 27 | C | 28 | B | 29 | C | 30 | D |
| 31 | A | 32 | D | 33 | A | 34 | A | 35 | C |    |   |

### SECTION I — MULTIPLE CHOICE

1. A 0.40 kg object moving at  $7.0 \text{ m s}^{-1}$  is struck by a force that acts along its direction of motion for 0.27 s. The force varies as  $F(t) = 79.0 \sin(\pi t/T)$  newtons, where  $T = 0.27 \text{ s}$ . What is the speed of the object just after the force stops? [Impulse with variable forces]

**Correct answer: D —  $40.9 \text{ m s}^{-1}$**

- Impulse–momentum theorem:  $J = \Delta p = m(v - u)$ .
- $v = u + J \div m = 7.0 + 13.6 \div 0.40 = 40.9 \text{ m s}^{-1}$
- Why the other options are wrong:
- A ( $-26.9 \text{ m s}^{-1}$ ): subtracted the change
- B ( $20.6 \text{ m s}^{-1}$ ): forgot to divide by the mass
- C ( $33.9 \text{ m s}^{-1}$ ): forgot the initial speed

LOS: Impulse with variable forces

#### KEY TAKEAWAY

Impulse from a time-varying force is the area under the  $F$ – $t$  curve:  $J = \int F \, dt = \Delta p$ . For  $F_0 \sin(\pi t/T)$  the area over one half-cycle is  $2F_0 T/\pi$ .

2. A particle moves along the  $x$ -axis with position  $x(t) = 0.600t^3 - 5.70t^2 + 7.70t$ , where  $x$  is in metres and  $t$  is in seconds. What is the particle's acceleration at  $t = 3.5 \text{ s}$ ? [Kinematics with calculus]

**Correct answer: A —  $1.20 \text{ m s}^{-2}$**

- Acceleration is the derivative of velocity:  $a(t) = dv/dt = 3.60t - 11.4$ .
- $a(3.5) = 3.60 \times 3.5 - 11.4 = 1.20 \text{ m s}^{-2}$
- Why the other options are wrong:
- B ( $3.60 \text{ m s}^{-2}$ ): dropped the constant term
- C ( $4.20 \text{ m s}^{-2}$ ): integrated instead of differentiating