

Print your Name:

1	2	3	4	5	Total	Grade
8	6	10	6	10	40	100

**Physics 1422
Exam 2**

**General Physics I-A
March 10, 2006**

All numerical answers require an explanation for credit, which must show symbolically any formulas you used. Numerical results must include correct units for full credit. Non-numerical answers (multiple-choice or matching) do not require an explanation. Answers and explanations must be legible for credit. Verbal explanations after the exam will not add points to your score.

Only work on the front of the page will be graded. You may use the backs of the pages as private scratch space to plan your strategy. This may help you write more readable calculations, which will maximize partial credit. In the event of a wrong answer, more partial credit can usually be assigned to an algebraic solution than a purely numerical one. Try not to do all the work on your calculator.

If you are not sure how to work a problem in terms of formulas, or do not have time to do so, a good verbal analysis may receive partial credit. If you need a result from an earlier part of a problem to work a later part, but do not have it, an algebraic solution will receive most of the credit.

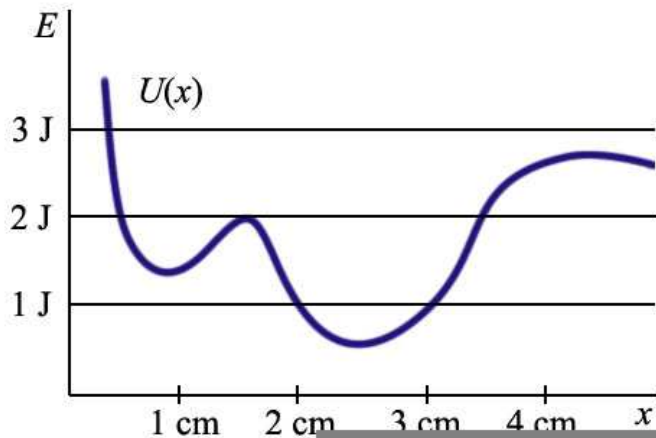
Useful Relations

Acceleration of gravity: $g = GM_e/R_e^2 = 9.8\text{m/s}^2 = 32\text{ft/s}^2$
Newton's Gravitational Constant: $G = 6.67 \times 10^{-11}\text{Nm}^2/\text{kg}^2$

Mass of Earth: $M_e = 6.0 \times 10^{24}\text{ kg}$
Radius of Earth: $R_e = 6.4 \times 10^6\text{ m}$

Air resistance: $R = C_1rv + C_2r^2v^2$
with $C_1 = 3.1 \times 10^{-4}\text{ Ns/m}^2$ and $C_2 = 0.87\text{ Ns}^2/\text{m}^4$.

1. [8pt] A conservative force acting on a particle is described by the potential energy shown in the figure.



Match each description to one of the energies shown. Read the graph carefully and pick the closest match to each description.

- | | | |
|--|----------|----------|
| (a) ____ Total energy of a particle oscillating between $x = 2$ cm and $x = 3$ cm. | A. 0 J | E. 1.8 J |
| (b) ____ Maximum total energy of any oscillating particle. | B. 0.5 J | F. 2.2 J |
| (c) ____ Maximum kinetic energy of a particle with total energy 2.5 J. | C. 1.0 J | G. 2.7 J |
| (d) ____ Minimum potential energy of a particle starting at $x = 1$ cm with a total energy of 1.9 J. | D. 1.4 J | H. 3.0 J |
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2. [6pt] Assume that a car is initially at rest, and for the purposes of this problem, assume the Earth is initially at rest also. The car then begins to accelerate.

(a) [2pt] As the car accelerates, the absolute value of the car's momentum changes by a certain amount, and that of the Earth changes by

- a) the same amount.
- b) zero.
- c) a smaller, but nonzero, amount.
- d) a larger amount.

(b) [2pt] In the process, the car gains some kinetic energy and the Earth

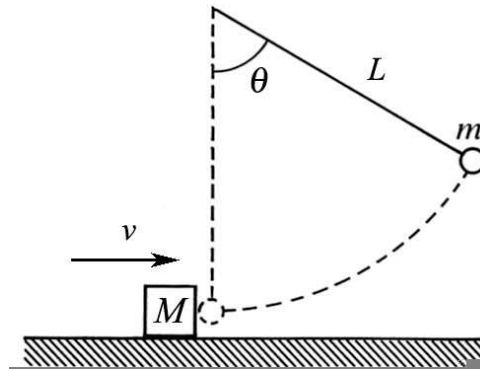
- a) loses kinetic energy.
- b) gains less kinetic energy.
- c) gains the same amount of kinetic energy.
- d) gains more kinetic energy.

(c) [2pt] If the car's engine produces constant power as it accelerates, the force exerted by the car on the Earth

- a) decreases with time.
- b) is constant in time.
- c) increases with time.
- d) cannot be determined without more information.

3. [10pt] A 16 kg box slides across a table and strikes a 50 g pendulum bob at a speed $v = 2.5$ m/s.

(a) [3pt] What is the speed of the pendulum bob just after the collision, assuming it is elastic? (Hint: a good approximation is possible, and will get full credit.)



(b) [3pt] What is the change in momentum of the box in the collision?

(c) [4pt] What is the maximum angle reached by the pendulum bob after the collision?

4. [6pt] In this problem, we will consider the motion of balloons under the influence of gravity and air resistance. The mass of air in the balloons does not influence the results: only the mass of the balloon itself is significant.

(a) [2pt] A two identical balloons inflated, but the second is inflated to twice the size of the first. Both balloons are dropped, and quickly reach a terminal speed. The terminal speed of the second balloon is

- a) the same as
- b) twice
- c) $\sqrt{2}$ times
- d) $1/\sqrt{2}$ times
- e) half

the terminal speed of the first.

(b) [2pt] Two balloons are inflated to the same size, but the second is twice as heavy as the first. Both balloons are dropped, and quickly reach a terminal speed. The terminal speed of the second balloon is

- a) the same as
- b) twice
- c) $\sqrt{2}$ times
- d) $1/\sqrt{2}$ times
- e) half

the terminal speed of the first.

(c) [2pt] Two identical balloons are inflated to the same size. One is dropped and the other is thrown horizontally. Which hits the ground first?

- a) The balloon that is dropped.
- b) The balloon that is thrown horizontally.
- c) They hit at the same time.
- d) There is no way to tell from the information given.

5. [10pt] A satellite is placed in a circular orbit 5 Earth radii above the equator (6 earth radii from the center of the Earth.)

(a) [3pt] What is the satellite's gravitational acceleration?

(b) [3pt] What is the satellite's orbital speed?

(c) [4pt] Suppose the satellite was placed in orbit by a rocket which burned its fuel quickly, giving its payload an initial speed v several km above the Earth. How large must v be for the satellite to coast into its orbit without further energy input?