AP® PHYSICS B (Form B)
2007 SCORING GUIDELINES

General Notes About 2007 AP Physics Scoring Guidelines

1. The solutions contain the most common method of solving the free-response questions and the allocation of points for this solution. Some also contain a common alternate solution. Other methods of solution also receive appropriate credit for correct work.

2. Generally, double penalty for errors is avoided. For example, if an incorrect answer to part (a) is correctly substituted into an otherwise correct solution to part (b), full credit will usually be awarded. One exception to this may be cases when the numerical answer to a later part should be easily recognized as wrong, e.g., a speed faster than the speed of light in vacuum.

3. Implicit statements of concepts normally receive credit. For example, if use of the equation expressing a particular concept is worth one point, and a student's solution contains the application of that equation to the problem but the student does not write the basic equation, the point is still awarded. However, when students are asked to derive and expression it is normally expected that they will begin by writing one or more fundamental equations, such as those given on the AP Physics exam equation sheet. For a description of the use of such terms as "derive" and "calculate" on the exams, and what is expected for each, see "The Free-Response Sections—Student Presentation" in the *AP Physics Course Description* .

4. The scoring guidelines typically show numerical results using the value $g = 9.8 \text{ m/s}^2$, but use of 10 m/s^2 is of course also acceptable. Solutions usually show numerical answers using both values when they are significantly different.

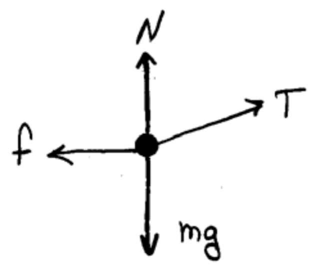
5. Strict rules regarding significant digits are usually not applied to numerical answers. However, in some cases answers containing too many digits may be penalized. In general, two to four significant digits are acceptable. Numerical answers that differ from the published answer due to differences in rounding throughout the question typically receive full credit. Exceptions to these guidelines usually occur when rounding makes a difference in obtaining a reasonable answer. For example, suppose a solution requires subtracting two numbers that should have five significant figures and that differ starting with the fourth digit (e.g., 20.295 and 20.278). Rounding to three digits will lose the accuracy required to determine the difference in the numbers, and some credit may be lost.

AP® PHYSICS B
2007 SCORING GUIDELINES (Form B)

Question 1

15 points total **Distribution of points**

(a) 4 points



For each of the forces above with arrow correctly drawn and labeled, 1 point was awarded — 4 points

Notes:
The force vector T could be shown in component form or as one force, but not both.
For extraneous forces, 1 point was deducted.

(b) 4 points

$\sum F_y = 0$

$N + T\sin\theta - mg = 0$

For a correct force equation — 1 point

$N = mg - T\sin\theta$

For calculating the *mg* term correctly — 1 point

For calculating the $T\sin\theta$ term correctly — 1 point

$N = (15\text{ kg} + 5\text{ kg})(9.8\text{ m/s}^2) - (55\text{ N})\sin 20°$

For the correct numerical answer with units — 1 point

$N = 177\text{ N}$ (181 N if $g = 10\text{ m/s}^2$ is used)

(c) 3 points

$\sum F_x = ma$

For a correct Newton's second law equation involving horizontal forces — 1 point

$T\cos\theta - f = ma$

$$a = \frac{T\cos\theta - f}{m}$$

For the correct relationship between the frictional and normal forces — 1 point

$f = \mu N$

For correct calculation of the frictional force using the value of *N* from part (b) — 1 point

$f = (0.22)(177\text{ N}) = 38.9\text{ N}$ (39.8 N if $g = 10\text{ m/s}^2$ is used)

$$a = \frac{(55\text{ N})\cos 20° - 38.9\text{ N}}{20\text{ kg}}$$

$a = 0.64\text{ m/s}^2$ (0.59 m/s^2 if $g = 10\text{ m/s}^2$ is used)

Question 1 (continued)

Distribution of points

(d) 2 points

For the correct work equation — 1 point

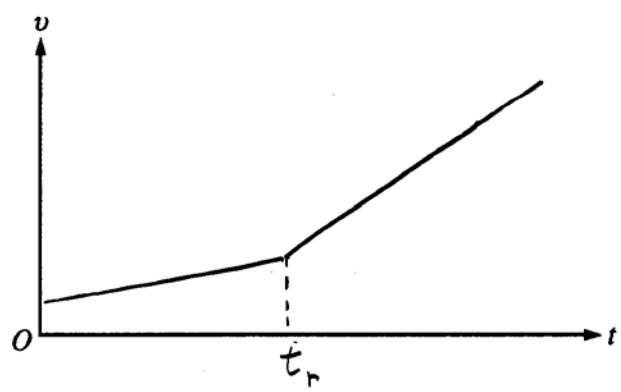
$W = (T\cos\theta)d$

For substituting the correct displacement — 1 point

$W = (55\text{ N})\cos 20°(7.0\text{ m})$

$W = 360\text{ J}$

(e) 2 points



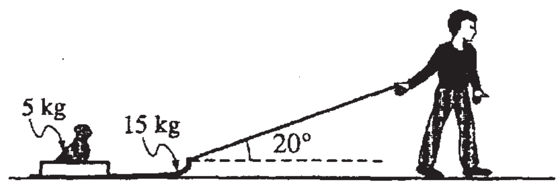
For each section of the graph correctly drawn as above, 1 point was awarded. — 2 points

<u>Note:</u> *The second point was awarded only if the change at* t_r *was abrupt.*

B1A

PHYSICS B
SECTION II
Time—90 minutes
7 Questions

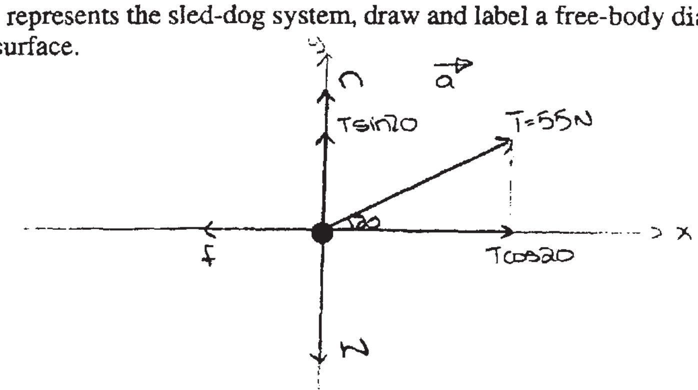
Directions: Answer all seven questions, which are weighted according to the points indicated. The suggested times are about 17 minutes for answering each of Questions 1 and 3 and about 11 minutes for answering each of Questions 2 and 4-7. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part, NOT in the lavender insert.



1. (15 points)

A child pulls a 15 kg sled containing a 5.0 kg dog along a straight path on a horizontal surface. He exerts a force of 55 N on the sled at an angle of 20° above the horizontal, as shown in the figure above. The coefficient of friction between the sled and the surface is 0.22.

(a) On the dot below that represents the sled-dog system, draw and label a free-body diagram for the system as it is pulled along the surface.



(b) Calculate the normal force of the surface on the system.

$\Sigma F_y = 0 \quad n + T\sin 20 = N$

$T = 55N \quad N = mg = (5+15)(9.8) = 196N$

$\Rightarrow \quad n + (55)\sin 20 = 196$

$n = 177\ N.$

GO ON TO THE NEXT PAGE.

(c) Calculate the acceleration of the system.

$\Sigma F_x = ma \qquad T\cos 20 - f = ma \qquad f = \mu n$

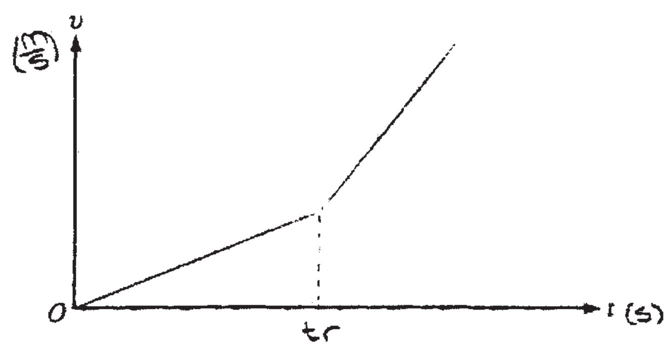
$\Rightarrow f = (0.22)(177) \qquad a = \dfrac{T\cos 20 - f}{m}$

$a = \dfrac{(55)\cos 20 - (0.22)(177)}{(15+5)} = 0.64\ \frac{m}{s^2}$

(d) Calculate the work done by the child's pulling force as the system moves a distance of 7.0 m.

$W = F_{\parallel} x = (T\cos 20)(x) = (55)\cos 20 (7.0) = 362\ J.$

(e) At some later time, the dog rolls off the side of the sled. The child continues to pull with the same force. On the axes below, sketch a graph of speed v versus time t for the sled. Include both the sled's travel with and without the dog on the sled. Clearly indicate with the symbol t_r the time at which the dog rolls off.



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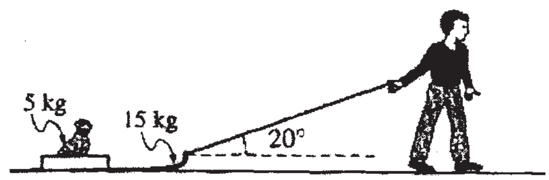

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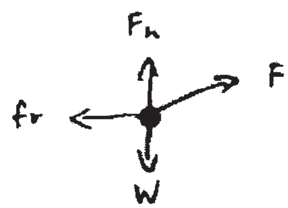


(b) Calculate the normal force of the surface on the system.

$F \sin\theta = 55 \sin(20) = 18.8\ N$

$(15+5)(9.8) = 196\ N$

$F_n = 196 - 18.8 = 177.2\ N$

GO ON TO THE NEXT PAGE.

(c) Calculate the acceleration of the system.

$F = ma$

$55 \sin 20 = (5+15)a$

$a = 0.94 \text{ m/s}^2$

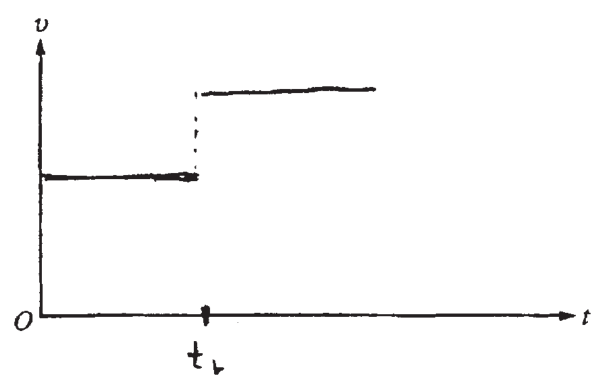
(d) Calculate the work done by the child's pulling force as the system moves a distance of 7.0 m.

$W = Fd$

$= 55 \sin 20 \times 7$

$= 131.67 \text{ J}$

(e) At some later time, the dog rolls off the side of the sled. The child continues to pull with the same force. On the axes below, sketch a graph of speed v versus time t for the sled. Include both the sled's travel with and without the dog on the sled. Clearly indicate with the symbol t_r the time at which the dog rolls off.



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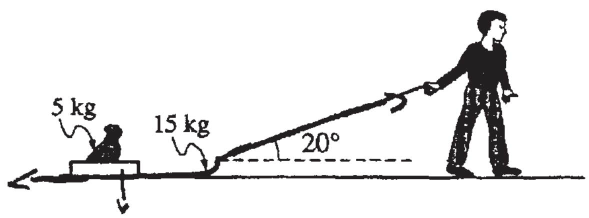

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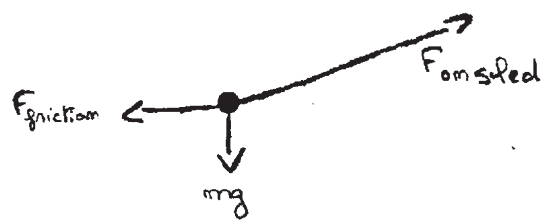


(b) Calculate the normal force of the surface on the system.

m = 5 + 15 = 20 Kg
a = g = 10 m/s²
μ = 0.22

F = 20×10 × 0.22 (cos 20)

F = 41.34647 N

GO ON TO THE NEXT PAGE.

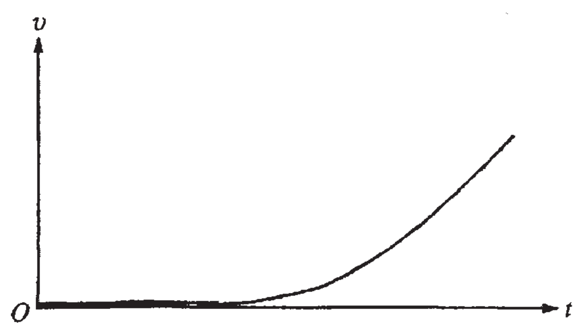
(c) Calculate the acceleration of the system.

F = ma
41.34647 = 20 × a
a = $\frac{41.34647}{20}$
a = 2.06732 m/s²

(d) Calculate the work done by the child's pulling force as the system moves a distance of 7.0 m.

w = F × d
w = 41.34647 × 7.0
w = 289.42529 J

(e) At some later time, the dog rolls off the side of the sled. The child continues to pull with the same force. On the axes below, sketch a graph of speed v versus time t for the sled. Include both the sled's travel with and without the dog on the sled. Clearly indicate with the symbol t_r the time at which the dog rolls off.



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AP® PHYSICS B
2007 SCORING COMMENTARY (Form B)

Question 1

Sample: B1A
Score: 14

The only point lost in this response was in part (a), for showing both the tension T and its components as if they were individual forces.

Sample: B1B
Score: 9

Full credit was earned for parts (a) and (b). In parts (c) and (d) the student again uses only the vertical component of the tension and no correct analysis of the horizontal forces. Part (c) earned no credit, and part (d) earned 1 point for using the correct displacement. Part (e) earned no credit.

Sample: B1C
Score: 4

Part (a) earned only 3 points, since the normal force is missing. The only other point earned was in part (d), where the student uses the correct displacement.