AP® Physics B
2002 Sample Student Responses

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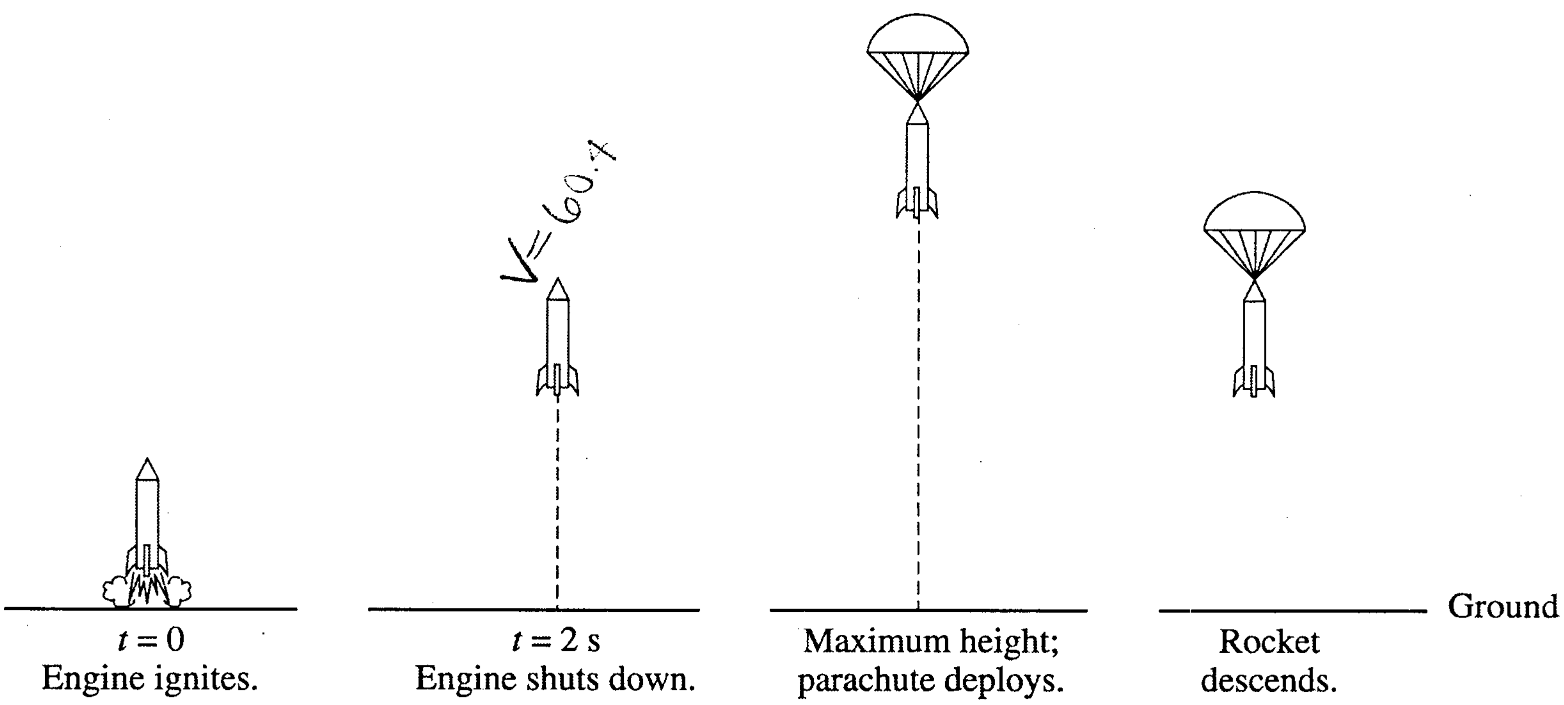
PHYSICS B
SECTION II
Time—90 minutes
7 Questions

Directions: Answer all seven questions, which are weighted according to the points indicated. The suggested time is about 15 minutes for answering each of questions 1-4, and about 10 minutes for answering each of questions 5-7. 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 green insert.



J = Ft = 20
F = 10N

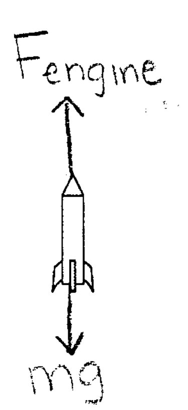
Note: Figures not drawn to scale.

1. (15 points)

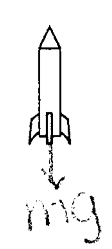
A model rocket of mass 0.250 kg is launched vertically with an engine that is ignited at time $t = 0$, as shown above. The engine provides an impulse of 20.0 N·s by firing for 2.0 s. Upon reaching its maximum height, the rocket deploys a parachute, and then descends vertically to the ground.

(a) On the figures below, draw and label a free-body diagram for the rocket during each of the following intervals.

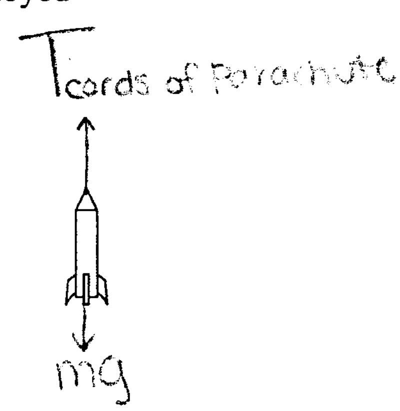
i. While the engine is firing



ii. After the engine stops, but before the parachute is deployed



iii. After the parachute is deployed



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(b) Determine the magnitude of the average acceleration of the rocket during the 2 s firing of the engine.

$\Sigma F = m\vec{a}$

$J = Ft$

$20\,Ns = F(2\,s)$

$F = 10N$

$10N - mg = ma$

$10N - .25kg(9.8\,m/s^2) = .25kg\,\vec{a}$

$\boxed{\vec{a} = 30.2\,m/s^2}$

(c) What maximum height will the rocket reach?

$V = V_0 + at$

$V = 0\,m/s + 30.2\,m/s^2(2s)$

$V = 60.4\,m/s$

$\Delta y = V_0 t + \frac{1}{2}at^2$

$\Delta y = \frac{1}{2}(30.2\,m/s^2)(2s)^2$

$\Delta y = 60.4\,m$

$K = U_G$

$\frac{1}{2}mv^2 = mg\Delta y$

$\frac{1}{2}(60.4\,m/s)^2 = 9.8(\Delta y)$

$\Delta y = 186.13\,m$

$\Sigma \Delta y = 60.4 + 186.13 = \boxed{246.53\,m}$

(d) At what time after $t = 0$ will the maximum height be reached?

$V = V_0 + at$

$0 = (60.4) + -9.8\,m/s^2(t)$

$t = 6.16s + 2s = \boxed{8.16s}$

GO ON TO THE NEXT PAGE.

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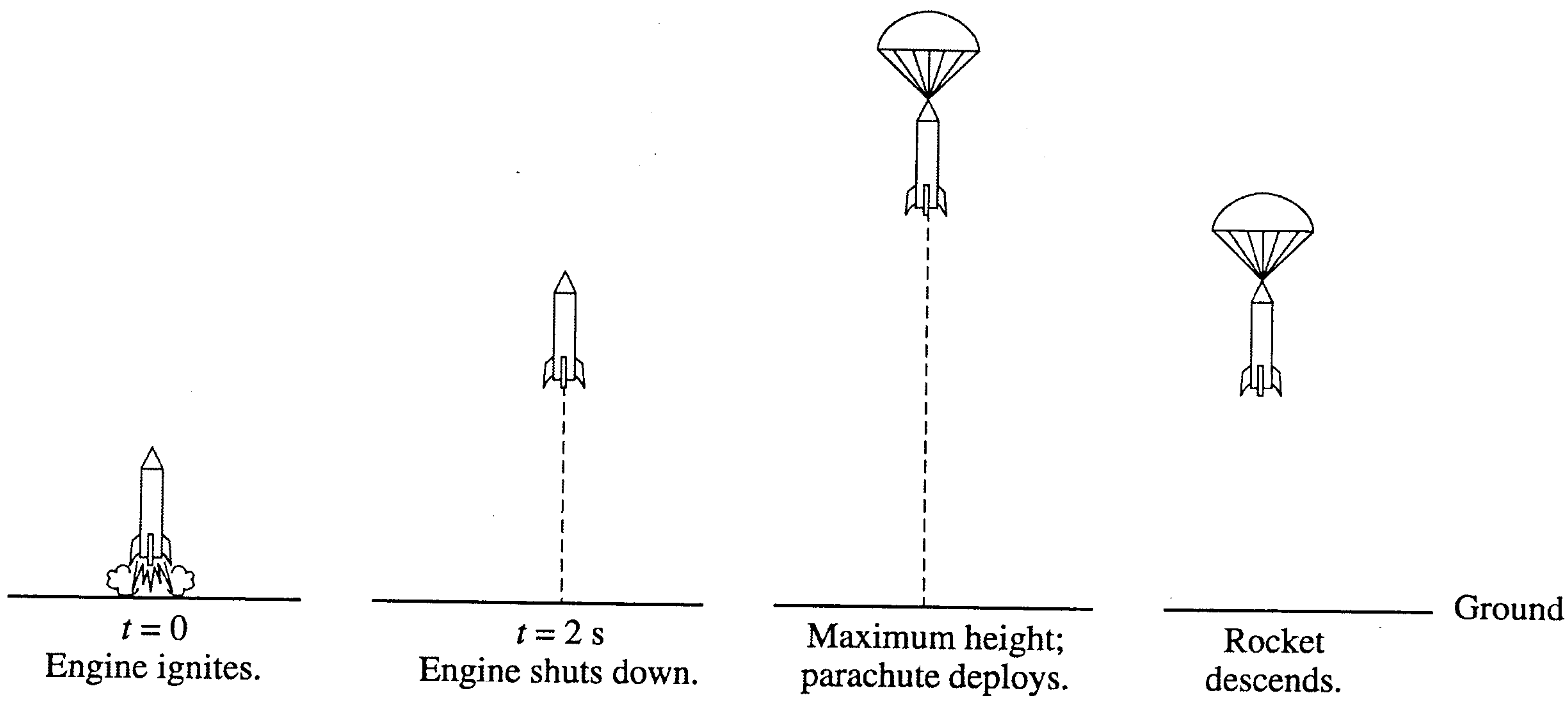

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1. (15 points)

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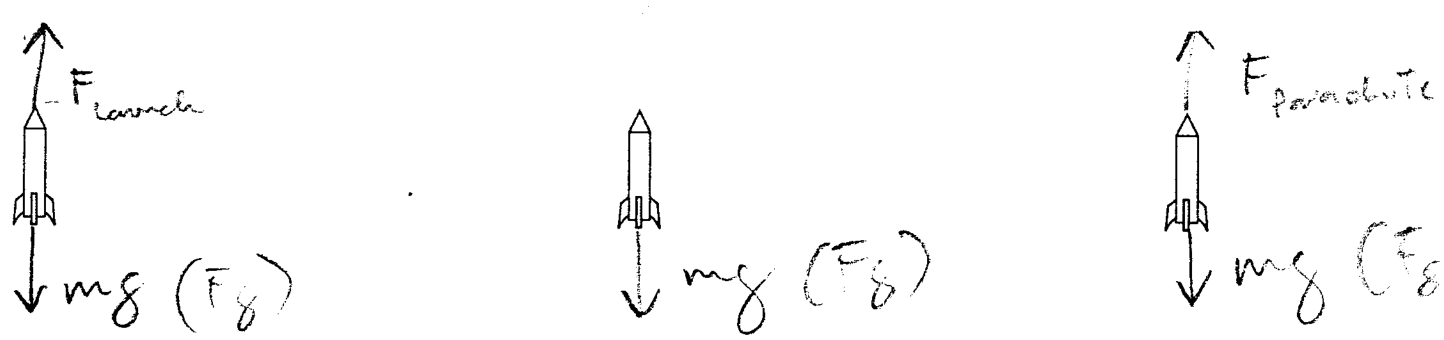
   (a) On the figures below, draw and label a free-body diagram for the rocket during each of the following intervals.

   i. While the engine is firing

   ii. After the engine stops, but before the parachute is deployed

   iii. After the parachute is deployed



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(b) Determine the magnitude of the average acceleration of the rocket during the 2 s firing of the engine.

$J = F\Delta T$ $\quad$ $F = ma$

$20 = F \cdot 2$ $\quad$ $10 = .25a$

$F = 10N$ $\quad$ $a = 40 m/s^2$

$a - g = a_{avg}$

$40 - 9.8 = 30.2 m/s^2$

(c) What maximum height will the rocket reach?

$v = v_0 + at$

$v = 0 + 30.2 \cdot 2 = 60.4 m/s$ $\quad$ } 1st 2 sec.

$v^2 = v_0^2 + 2ax$

$0 = (60.4)^2 + 2(-9.8)x$ $\quad$ $V_f = 0$ when rocket reaches max height

$x = 186.13 m$

(d) At what time after $t = 0$ will the maximum height be reached?

$v = V_0 + at_I$ $\quad$ T_I = Time after 1st 2 sec

$0 = 60.4 + (-9.8) \cdot T_I$

$T = 6.16 s$

$T + T_I = T_{Total}$

$2 + 6.16 = 8.16 s$

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