1a) $$h'(8) \approx \frac{h(9)-h(7)}{9-7} = \boxed{\frac{11-7}{2}} = 2 \text{ butterflies/day}$$

+1 approx

The number of butterflies is inc at approx 2 butterflies' per day when t=8 days.

+1 interp. w/ units

b) h is diff, so h is cont

+ h is cont and diff

$$\frac{h(7)-h(5)}{7-5} = \frac{7-4}{2} = \frac{3}{2}$$

+1 sec slope

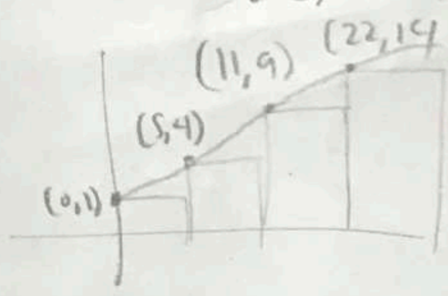
By the MVT, there must be at least one time t in (5, 7) such that $h'(t) = 1.5$.

+1 conc.

c)

$$\underbrace{\quad}_{5}\ \underbrace{\quad}_{4}\ \underbrace{\quad}_{5}$$

0	5	9	14
1	4	11	22



$$\boxed{5(1) + 4(4) + 5(11)} = 5 + 16 + 55 = 76$$

+1 left riemann sum

This approx is less than $\int_0^{14} h(t)\,dt$ because h is inc and we used a left riemann sum

+1 underest.

+1 reason

d) $g(t) = 7e^{\frac{1}{7}(t-1)} + \cos(2t-16)$

$g'(t) = 7e^{\frac{1}{7}(t-1)}\left(\frac{1}{7}\right) - \sin(2t-16)(2)$

$e^{\frac{1}{7}(t-1)} - 2\sin(2t-16)$

$g''(t) = \frac{1}{7}e^{\frac{1}{7}(t-1)} - 4\cos(2t-16)$ +1 $g''(t)$

$g''(8) = \frac{1}{7}e^{\frac{1}{7}(7)} - 4\cos(2(8)-16)$

$\frac{1}{7}e - 4\cos(0)$

$\frac{1}{7}e - 4$

negative

Since $g''(8)<0$, the number of keos is inc at a dec rate at $t=8$. +1 inc at a dec rate since $g''(8)<0$

Since $g''(8)$ is neg, the graph of $g(t)$ is concave down at $t=8$. +1 g is conc down at $t=8$.

e) B - # of keos

x - daily high temp

Given: when $B=100$, $\frac{dx}{dt} = 2°F/dt$

Find: $\frac{dB}{dt}$ when $B=100$

$$B(x) = 50\sqrt{k+2x}$$

+1 $\frac{dB}{dt}$ chain rule & implicit diff

$$\frac{dB}{dt} = 50\left(\frac{1}{2}(k+2x)^{-\frac{1}{2}}\right)\left(2\frac{dx}{dt}\right)$$

$$\left.\frac{dB}{dt}\right|_{B=100} = 50\left(\frac{1}{2}\left(k+2\left(\frac{4-k}{2}\right)\right)^{-\frac{1}{2}}\right)(2(2))$$

$$100 = 50\sqrt{k+2x}$$

$$2 = \sqrt{k+2x}$$

$$4 = k+2x$$

$$2x = 4-k$$

$$x = \frac{4-k}{2}$$

$$\left.\frac{dB}{dt}\right|_{B=100} = 50\left(\frac{1}{2}(\cancel{k}+4-\cancel{k})^{-\frac{1}{2}}\right)(4)$$

$$\boxed{50\left(\frac{1}{4}\right)4 \ \frac{\text{bees}}{\text{day}}}$$

$$50 \ \frac{\text{bees}}{\text{day}}$$

+1 ans w/ units

2. a) $g(9) = 3(9) + \int_2^9 f(t)\,dt$

$27 + \frac{1}{4}\pi + 1(2) + \frac{1}{2}\frac{1}{2}(1) - \frac{1}{2}\left(\frac{5}{2}\right)(3) + \frac{1}{2}(3)(1)$

+1 g(9)

$27 + \frac{\pi}{4} + 2 + \frac{1}{4} - \frac{15}{4} + \frac{3}{2}$

$29 + \frac{\pi}{4} - \frac{7}{2} + \frac{3}{2}$

$27 + \frac{\pi}{4}$

$g'(x) = \frac{d}{dx}\left(3x + \int_2^x f(t)\,dt\right)$

$g'(x) = 3 + f(x)$

$g'(9) = 3 + f(9)$

$= \boxed{3+3}$ +1 g'(9)

6

b) candidates for max value are end pts: $x = -4$, $x = 9$

+1 considers endpts

and critical pts: $g'(x) = 0$

$3 + f(x) = 0$

$f(x) = -3$

$\rightarrow x = -1,\ x = 7$ +1 critical pts $x=-1, 7$

x	$g(x)$
-4	$3(-4) + \int_2^{-4} f(t)dt = -12 - \int_{-4}^{2} f(t)dt$ $-12 - (-\frac{1}{2}\pi(3)^2)$ $-12 + \frac{9}{2}\pi$
-1	$3(-1) + \int_2^{-1} f(t)dt = -3 - (-\frac{1}{4}\pi(3)^2) = -3 + \frac{9}{4}\pi$
7	$3(7) + \int_2^{7} f(t)dt = 21 + \frac{1}{4}\pi + 2(1) - \frac{1}{2}(1)(1+3)$ $= 21 + \frac{1}{4}\pi + \cancel{2} - \cancel{2} = 21 + \frac{1}{4}\pi$
9	$27 + \frac{\pi}{4}$ (from part a) $\leftarrow$ largest

The max value occurs at $x = 9$ +1 answer w/ just

OR

candidates for abs max are endpts: $x=-4$, $x=9$ +1 considers endpts
and critical pts:

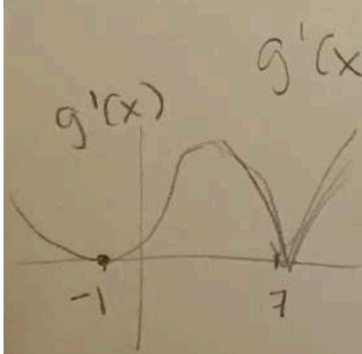
$g'(x) = 0$

$3 + f(x) = 0$

$f(x) = -3$

$x = -1, x = 7$ +1 critical pts $x=-1, 7$

$g'(x) = 3 + f(x) \rightarrow f(x)$ graph shifted up 3



$g'(x)$ is always greater than or equal to zero,
$g'(x)$ is never negative, so g never decreases
Therefore $x=9$ must be where the max is because g constantly increases. +1 ans w/ just

c) $f'(2)$ does not exist because there is a vert tangent at $x=2$

+1 ans w/ just.

d) $\lim_{x\to 3} \dfrac{8g(2x)-2\pi-160}{e^{x-3}-1}$

$\lim_{x\to 3} 8g(2x)-2\pi-160$

$g(6) = 3(6) + \int_2^6 f(t)\,dt$

$18 + \frac{1}{4}\pi + 2$

$20 + \frac{1}{4}\pi$

$8g(6) - 2\pi - 160$

$8\left(20+\frac{1}{4}\pi\right) - 2\pi - 160$

+1 conditions of l'hopital's rule

$160 + 2\pi - 2\pi - 160$

0

$\lim_{x\to 3} e^{x-3} - 1 = e^0 - 1 = 0$

By l'hopital's rule

$g'(6) = 3 + f(6)$

$3 - 1 = 2$

+1 ans

+1 correct deriv. in l'hopital's rule

$\lim_{x\to 3} \dfrac{8g(2x)-2\pi-160}{e^{x-3}-1} = \lim_{x\to 3} \dfrac{8g'(2x)(2)}{e^{x-3}} = \dfrac{8g'(6)(2)}{e^{3-3}} = \boxed{\dfrac{8(2)(2)}{1}} = 32$

Suggested Scoring:

Raw Score:	Exam Score:
14-23	5
12-13	4
9-11	3
6-8	2
0-5	1

As previously mentioned, College Board has not predetermined the scores needed to earn a 3,4, or 5 for this year. The level of difficulty of the exam will evaluated with the goal of having scoring distributions to be similar to previous years. However, Q1 will be worth 60% of your overall score and Q2 will be worth 40%. This rubric is just a potential guide and meant to be a helpful tool to gauge your performance. It is not a guarantee of how many points questions will be worth and where the cuts off are.