

```

1 # Import modules
2 from q2_c import *
3
4
5 def s(T):
6     # Calculate entropy at a given temperature
7     return ((2 * np.pi ** 2) / 45) * np.sqrt(g_star_s(T)) * (T) ** 3
8
9
10 def calculate_gw(omega, rho, m, s):
11     # Calculates gw given various parameters
12     return ((6e-17) / ((omega * rho) / (m * s))) ** (1 / 3.8)
13
14
15 # Calculate critical rho today
16 today_in_seconds = 6.62e41
17 logt_today = np.log(6.62e41)
18 T_today = T_approx_exp(a_pieewise(logt_today))
19 H0_GeV = (np.pi / (3 * np.sqrt(10))) * np.sqrt(g_star(T_today)) * (T_today ** 2
    ) / M_pl # GeV
20 inverse_gev_to_seconds = (1.52e24)
21 H0_seconds = (1 / H0_GeV) / inverse_gev_to_seconds
22 G = 6.67e-8 # grams/ cm3 s2
23 M_pl_sq = 1 / (8 * np.pi * G)
24
25 # Parameters needed to calculate gw
26 gcm3_to_gev4 = 2.32e17
27 critical_rho_gev4 = (1 / ((3 * H0_seconds ** 2) / M_pl_sq)) / gcm3_to_gev4
28 omega_x = 0.27
29 s_today = s(T_today)
30 m_x = 500
31
32 # Print result
33 print("gw: {}".format(round(calculate_gw(omega_x, critical_rho_gev4, m_x, s_today
    ), 3)))
34

```