

LIGO-GW150914 (10 points)

Part A: Newtonian (conservative) orbits (3.0 points)

A.1 (1.0 pt)

$$n =$$

$$\alpha =$$

A.2 (1.0 pt)

$$A(\mu, \Omega, L) =$$

A.3 (1.0 pt)

$$\beta =$$

Part B: Introducing relativistic dissipation (7.0 points)

B.1 (1.0 pt)

$$k =$$

$$a_1 =$$

$$a_2 =$$

$$a_3 =$$

$$b_1 =$$

$$b_2 =$$

$$b_3 =$$

$$c_{12} =$$

$$c_{13} =$$

$$c_{23} =$$

$$c_{21} =$$

$$c_{22} =$$

$$c_{23} =$$

$$c_{31} =$$

$$c_{32} =$$

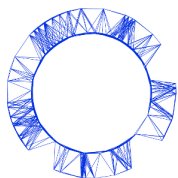
$$c_{33} =$$

B.2 (1.0 pt)

$$\xi =$$

B.3 (1.0 pt)

$$M_c =$$



B.4 (2.0 pt)

$p =$

B.5 (1.0 pt)

$M_c \simeq$

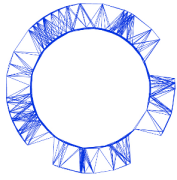
$M \simeq$

B.6 (1.0 pt)

$L \simeq$

$\frac{R_\odot}{R_{\max}} \simeq$

$\frac{v_{\text{col}}}{c} \simeq$



Where is the neutrino? (10 points)

Part A. ATLAS Detector Physics (4.0 points)

A.1 (0.5 pt)

$$r =$$

A.2 (0.5 pt)

$$p =$$

A.3 (1.0 pt)

$$\xi = \quad n = \quad k =$$

A.4 (1.0 pt)

$$\alpha =$$

A.5 (0.5 pt)

$$\Delta E =$$

A.6 (0.5 pt)

$$\omega(t) =$$

Part B. Finding the neutrino (6.0 points)

B.1 (1.5 pt)

$$m_W^2 =$$

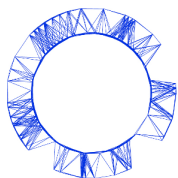
B.2 (1.5 pt)

$$p_z^\nu = \quad \text{or} \quad p_z^\nu =$$

B.3 (1.0 pt)

$$m_t = \quad \text{or} \quad m_t =$$

Theory



IPhO 2018
Lisbon, Portugal

A2-2

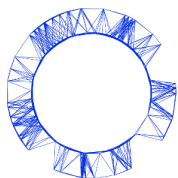
English (Official)

B.4 (1.0 pt)

Most likely candidate:

B.5 (1.0 pt)

$d =$



Physics of Live Systems (10 points)

Part A. The physics of blood flow (4.5 points)

A.1 (1.3 pt)

$$Q_i =$$

A.2 (0.5 pt)

$$Q_0 =$$

A.3 (2.0 pt)

$$P_{\text{out}} =$$

Condition:

A.4 (0.7 pt)

$$\text{Maximum } h =$$

Part B. Tumour growth (5.5 points)

B.1 (1.0 pt)

$$v =$$

B.2 (1.7 pt)

Temperature:

B.3 (0.5 pt)

$$\mathcal{P}_{\text{min}} =$$

B.4 (2.3 pt)

$$\frac{\delta Q_{N-1}}{Q_{N-1}} \simeq$$