



## X-ray jets from active galactic nuclei

### Part A: 1D fluid model of a jet (3.8 points)

**A.1** (0.3 pt)

$$n'(s) =$$

**A.2** (0.2 pt)

$$F_p(s) =$$

**A.3** (0.5 pt)

**A.4** (0.6 pt)

**A.5** (0.6 pt)

$$\frac{dF_1}{ds} =$$

**A.6** (0.4 pt)

Expression for calculating  $\dot{M}$ :

$$\dot{M}_1 =$$

$$\dot{M}_2 =$$

**A.7** (0.5 pt)

Expression:

$$\Pi =$$

Numerical:

$$\Pi =$$



**A.8** (0.5 pt)

$$F_{Pr} =$$

**A.9** (0.2 pt)

Relationship:

$$\% \text{ deviation} =$$

**Part B: Gas of ultra relativistic electrons (2.2 points)**

**B.1** (0.2 pt)

**B.2** (0.8 pt)

$$\frac{\Delta p_z}{\Delta t} =$$

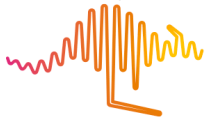
Theory



Asian  
Physics  
Olympiad  
Adelaide 2019

**A2-3**  
English (Official)

**B.3** (0.6 pt)



**B.4** (0.6 pt)

**Part C: Synchrotron emission (1.7 points)**

**C.1** (0.7 pt)

$\Omega =$

**C.2** (0.5 pt)

$\Delta t =$

**C.3** (0.3 pt)

$\nu_{\text{chr}} =$



**C.4** (0.2 pt)

$\tau =$

**Part D: Synchrotron emission from an AGN jet (2.3 points)**

**D.1** (0.4 pt)

$B =$

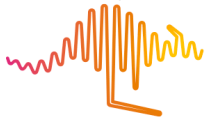
**D.2** (1.0 pt)

$f(\epsilon) =$

**D.3** (0.3 pt)

Synchrotron cooling will make the distribution:

shallower,  steeper,  other



## D.4 (0.6 pt)

AGN	Knot	Likely cause of cooling	Question parts which support your conclusion
Cen A	AX1C	<input type="checkbox"/> synchrotron cooling <input type="checkbox"/> adiabatic expansion <input type="checkbox"/> neither	
Cen A	BX2	<input type="checkbox"/> synchrotron cooling <input type="checkbox"/> adiabatic expansion <input type="checkbox"/> neither	
M87	HST-1	<input type="checkbox"/> synchrotron cooling <input type="checkbox"/> adiabatic expansion <input type="checkbox"/> neither	
M87	Knot A	<input type="checkbox"/> synchrotron cooling <input type="checkbox"/> adiabatic expansion <input type="checkbox"/> neither	