

**Q11** A black hole of mass  $10^6 M_{\odot}$  is surrounded by an accretion disc. Suppose that the material in the accretion disc moves in circular orbits. Consider a small blob of material in this accretion disc with orbital radius  $3.0 \times 10^9$  m. Find the orbital speed of the blob. [Hint: This is a similar exercise to finding the orbital speed of a planet, most recently discussed on page 15 of Block 3.]

Choose from the key the value closest to yours.

KEY for Q11

- A  $5 \times 10^{-9} \text{ m s}^{-1}$       D  $2 \times 10^{10} \text{ m s}^{-1}$   
 B  $2 \times 10^4 \text{ m s}^{-1}$       E  $5 \times 10^{16} \text{ m s}^{-1}$   
 C  $0.7c$                   F  $0.5c^2$

Pencil across *one* cell in row 11.

**Q12** Which *one* statement regarding clusters of galaxies is *false*?

KEY for Q12

- A Giant elliptical galaxies are often found near the centres of rich clusters. ✓  
 B Galactic mergers may occur whereby a large galaxy in a rich cluster may grow into a cD galaxy. ✓  
 C Rich clusters often contain a higher proportion of spiral galaxies than do sparse clusters. ✓  
 D The spatial distribution of clusters adds to our knowledge of the spatial distribution of dark matter. ✓  
 E A change in the accepted value of the Hubble constant would *not* change our estimates of the relative distances of different clusters of galaxies. ✓  
 F The *value* of Hubble's constant reflects the rate (on average) at which clusters are receding from each other. ✓

Pencil across *one* cell in row 12.

$$v^2 = \frac{GM}{r}$$

$$v^2 = \frac{GM}{r} = \frac{6.67 \times 10^{-11} \times 10^6}{3 \times 10^9} \times 2 \times 10^3$$

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