

**Q5** In which *two* of the following circumstances would ejecta fragments from the top of a volcanic eruption column take *longer* to fall to the ground than ejecta clasts 1 cm in diameter from the top of a 40 km high volcanic eruption column on the Earth? Pencil across *two* cells in row 5.

KEY for Q5

- ☒ A Fragments of the same diameter but higher density, from an eruption column on the Earth of the same height.
- ☒ B Fragments of the same density but 2 cm in diameter, from an eruption column on the Earth of the same height.
- ☒ C Fragments of the same density and same diameter, from a 60 km high eruption column on the Earth.
- ☒ D Fragments of the same density and same diameter, from a 40 km high eruption column on a planet with the same surface gravity as the Earth but a less dense atmosphere.
- ☒ E Fragments of the same density and same diameter, from a 30 km high eruption column on a planet with the same surface gravity as the Earth but a less dense atmosphere.
- ☒ F Fragments of the same density and same diameter, from a 40 km high eruption column on a planet with the same surface gravity as the Earth but a denser atmosphere.
- ☒ G Fragments of the same density and same diameter, from a 40 km high eruption column on a planet with the same atmospheric density as the Earth but greater surface gravity.
- ☒ H Fragments of the same density and same diameter, from a 30 km high eruption column on a planet with the same atmospheric density as the Earth but greater surface gravity.

**Q6** Choose from the key A–F the *one* statement that is *true*. Pencil across *one* cell in row 6.

KEY for Q6

- ☒ A Oxygen,  $O_2$ , in the atmosphere of the Earth contributes significantly to the greenhouse effect.
- ☒ B Without the greenhouse effect the Earth would, on average, be about 33 K colder.
- ☒ C The composition of planetary atmospheres above any cloud layers is the same as that below the clouds.
- ☒ D The total amount of nitrogen,  $N_2$ , in the Earth's atmosphere is 40 times greater than the amount in the atmosphere of Venus.
- ☒ E The most abundant molecule in the atmosphere of Jupiter is  $NH_3$ .
- ☒ F The haze surrounding Uranus is composed of water ice ( $H_2O$ ) crystals.

**Q7** Which *one* of the following statements about elliptical galaxies is *true*? Pencil across *one* cell in row 7.

KEY for Q7

- ☒ A Elliptical galaxies were spiral galaxies, but the spiral arms have become so tightly wound they can no longer be distinguished.
- ☒ B Elliptical galaxies have spiral arms but we cannot distinguish them because of the angle at which we are seeing the galaxy.
- ☒ C Elliptical galaxies generally have a smaller proportion of their mass in gas and dust than do spiral galaxies.
- ☒ D Elliptical galaxies classified as E10 are sausage-shaped.
- ☒ E Lenticular galaxies are a sub-set of elliptical galaxies.
- ☒ F Elliptical galaxies contain predominantly Population I stars.

**Q8** Which *two* of the following statements about isotropic homogeneous universes are *true*? Pencil across *two* cells in row 8.

KEY for Q8

- ☒ A A closed universe has spherical geometry with a well-defined centre and the angles of a triangle adding up to less than  $180^\circ$ .
- ☒ B A flat universe expands according to  $R(t) \propto t^{1/2}$  and so is hyperbolic in geometry.
- ☒ C In hyperbolic geometry, parallel lines diverge and there are no edges to the Universe.
- ☒ D On a small scale, spherical geometry may appear flat but hyperbolic geometry will not.
- ☒ E A flat universe is a special case of an open universe, except that the flat universe has a centre.
- ☒ F In an open universe, the circumference of a circle can be greater than  $2\pi$  times the radius, in which case the geometry is the 3D equivalent of saddle-shaped.
- ☒ G A flat universe expands according to  $R(t) \propto t^{2/3}$  and so is hyperbolic in geometry.