

Quiz V

This is a 50 minute closed-book exam; no notes. Please put your name on the top sheet. Answer all three questions. Explain your working and state any assumptions you have made.

1 (3 points) Circle the correct answer.

1. The Grashof number

- is independent of fluid properties.
- is a Reynolds number for free convection.
- is the same as the Rayleigh number.
- is always greater than 1.
- is proportional to h , the heat transfer coefficient.

2. A gray body

- is the same as a black body.
- does not emit radiation.
- is perfectly reflective.
- does not obey Planck's law.
- has frequency-independent absorptivity.

3. View factors

- are greater than 1.
- depend on the Stefan–Boltzmann law.
- are independent of the shape of objects.
- can only be found by numerical calculation.
- are purely geometrical.

2 (7 points) A radiator may be viewed as a one-sided vertical plane with width 1 m^2 and height 50 cm. If the ambient air is at 20°C and the radiator is at 40°C , calculate the heat flux out of the radiator. What happens if you repeat the calculation with the radiator immersed in water?

3 (10 points) A black horizontal disk with a diameter of 1 m, in contact with the ground, is being heated by solar radiation ($q = 1000 \text{ W/m}^2$). Heat is lost to the surrounding air at 25°C by natural convection. There is no forced convection. The surface opposite the sun is insulated from the boundary. Find the surface temperature. [$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$.]