Unit 13 - Week 11

Assignment 11

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-10-16, 23:59 IST.

1) In stably-stratified turbulence (SST), moderate stratification implies *1 point*

- $|\mathbf{u}.\nabla\mathbf{u}| \gg \rho g$
- $|\mathbf{u}.\nabla\mathbf{u}| \sim \rho g$
- $|\mathbf{u}.\nabla\mathbf{u}| \ll \rho g$
- None of the above.

No, the answer is incorrect.
Score: 0
Accepted Answers:
$|\mathbf{u}.\nabla\mathbf{u}| \sim \rho g$

2) For SST with weak stratification, we expect the kinetic energy spectrum in the inertial range to scale as *1 point*

- $k^{-11/5}$
- k^{-2}
- k^{-3}
- $k^{-5/3}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$k^{-5/3}$

3) Consider SST with moderate stratification. Which of the following statements concerning the kinetic and potential energy fluxes in the inertial range are true? Select ALL that apply. *1 point*

- $\Pi_u = \text{constant}$
- $\Pi_u + \Pi_\rho \approx \text{constant}$
- $\Pi_u \sim k^{-4/5}$
- $\Pi_\rho \approx \text{constant}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\Pi_u + \Pi_\rho \approx \text{constant}$
$\Pi_u \sim k^{-4/5}$
$\Pi_\rho \approx \text{constant}$

4) Choose the correct statement. *1 point*

- For thermal convection, kinetic energy is conserved when $\nu = \kappa = 0$
- In turbulent convection, kinetic energy is imparted into the system by buoyancy at all scales.
- In SST, kinetic energy is imparted into the system by buoyancy at large scales.
- None of the above statements are correct.

No, the answer is incorrect.
Score: 0
Accepted Answers:

In turbulent convection, kinetic energy is imparted into the system by buoyancy at all scales.

5) In turbulent convection, Bolgiano-Obukhov (BO) scaling is not applicable because *1 point*

- $\partial\Pi_u/\partial k < 0$ is essential for BO scaling, but this does not happen in turbulent convection.
- $\partial\Pi_u/\partial k > 0$ is essential for BO scaling, but this does not happen in turbulent convection.
- $\partial\Pi_u/\partial k = 0$ is essential for BO scaling, but this does not happen in turbulent convection.
- None of the above.

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\partial\Pi_u/\partial k < 0$ is essential for BO scaling, but this does not happen in turbulent convection.

6) In the inertial range in turbulent convection, the kinetic energy spectrum and the kinetic energy flux follow *1 point*

- $E_u(k) \sim k^{-4/3}$, $\Pi_u(k) \sim k^{1/3}$
- $E_u(k) \sim k^{-5/3}$, $\Pi_u(k) \approx \text{constant}$
- $E_u(k) \sim k^{-11/5}$, $\Pi_u(k) \sim k^{-4/5}$
- $E_u(k) \sim k^{-2}$, $\Pi_u(k) \sim k^{-4/3}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$E_u(k) \sim k^{-5/3}$, $\Pi_u(k) \approx \text{constant}$

7) The primary reason behind the scaling in Q.6 is *1 point*

- The buoyancy forcing $\mathcal{F}_B(k)$ is zero in the inertial range.
- The buoyancy forcing $\mathcal{F}_B(k)$ is weak in the inertial range.
- The buoyancy forcing $\mathcal{F}_B(k)$ is strong in the inertial range.
- None of the above.

No, the answer is incorrect.
Score: 0
Accepted Answers:
The buoyancy forcing $\mathcal{F}_B(k)$ is weak in the inertial range.

8) In a periodic box $[2\pi, 2\pi]$, consider the following flow field with a vector $\mathbf{w}$: *1 point*

$$\mathbf{u} = A\hat{x}\cos y + B\hat{y}\cos x + C(\hat{x} - \hat{y})\sin(x + y)$$
$$\mathbf{w} = A_w\hat{x}\cos y + B_w\hat{y}\cos x + C_w(\hat{x} - \hat{y})\sin(x + y)$$

The total energy of the vector field is

- $2(A_w^2 + B_w^2 + C_w^2)$
- $3A_w^2 + 4B_w^2 + 2C_w^2$
- $A_w^2 + B_w^2 + C_w^2$
- $\frac{A_w^2}{4} + \frac{B_w^2}{4} + \frac{C_w^2}{2}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{A_w^2}{4} + \frac{B_w^2}{4} + \frac{C_w^2}{2}$

9) For the flow field described in Q.8, the vector energy transferred to the wavenumber (1,0) is *1 point*

- 0
- $\frac{AB_wC_w}{8}$
- $\frac{AB_wC_w}{2}$
- $-AB_wC_w$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{AB_wC_w}{8}$

10) Which of the statements concerning passive vector turbulence are correct? Select ALL that apply. *1 point*

- In the inertial range, both kinetic energy flux and the vector energy flux are constant.
- The vector energy spectrum follows $k^{-5/3}$ in the inertial range.
- Vector forcing is active only at large scales.
- The vector energy spectrum follows $k^{-11/5}$ in the inertial range.

No, the answer is incorrect.
Score: 0
Accepted Answers:
In the inertial range, both kinetic energy flux and the vector energy flux are constant.

The vector energy spectrum follows $k^{-5/3}$ in the inertial range.

Vector forcing is active only at large scales.