17. Multiply the integrals $I = \int_0^\infty e^{-x^2} dx$ and $I = \int_0^\infty e^{-y^2} dy$, write as a double integral, convert to polar coordinates and find I.

18. Consider the double integral $\int_0^\infty \int_0^\infty e^{-xy} \sin x dx dy$, use Fubini's theorem to find $\int_0^\infty \frac{\sin x}{x} dx$.

19. Consider the complex integral $\int_C \frac{e^{iz}}{z} dz$ where C the boundary of the region between the circles of radius R and r with $R > r$ above the x exis. Let $R \to \infty$ and $r \to 0$ and use Cauchy's Residue theorem to find $\int_0^\infty \frac{\sin x}{x} dx$. Show that complex integrals become zero when necessary.

20. Find the area of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$. Also find the perimeter using Elliptic Integrals.

21. Find the volume of the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$. Also find surface area using Elliptic Integrals, use a modified form of spherical polar coordinates.

22. Use Divergence theorem to prove the Archimedes's Principle.

23. Let $u = u(x,y), s = s(x,y), t = t(x,y)$ and $\det \frac{\partial(s,t)}{\partial(x,y)} \neq 0$.
We rewrite $Au_{xx} + Bu_{xy} + Cu_{yy}$ as $\bar{A}u_{ss} + \bar{B}u_{st} + \bar{C}u_{tt} + \cdots$ after changing variables.
Show that $\bar{B}^2 - 4\bar{A}\bar{C} = \left(\det \frac{\partial(s,t)}{\partial(x,y)}\right)^2 (B^2 - 4AC)$.

24. Let $\boldsymbol{f}$ be a vector field continuous on an open connected set A in $\mathbb{R}^3$. Show that $\boldsymbol{f}$ is the gradient of some potential function in A iff the line integral of $\boldsymbol{f}$ is independent on any piecewise smooth path in A.

25. First question in MID

26. Second question in MID