a) use Green's thm:

$$\boxed{\oint_{\text{loop}} Q\,dy - P\,dx = \int_S \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y}\right) dx\,dy}$$

with $Q = x$, $P = -y$:

$$\hat{z} \oint_{\text{loop}} x\,dy - y\,dp = \hat{z} \int_S (1+1)\,dx\,dy = 2\int_S dx\,dy\,\hat{z} = \underline{\underline{2A\cdot\hat{z}}}$$

where A is area

b) Calculate it explicitly:

$$\vec{r} = \hat{x}\,a\cos\theta + \hat{y}\,b\sin\theta$$

$$\Rightarrow d\vec{r} = (-\hat{x}\,a\sin\theta + \hat{y}\,b\cos\theta)\,d\theta$$

$$\hookrightarrow \int_{\text{loop}} \vec{r}\times d\vec{r} = \hat{z}\oint_0^{2\pi} (ab\cos^2\theta + ab\sin^2\theta)\,d\theta =$$

$$= \hat{z}\,ab\cdot 2\pi = \underline{\underline{2\pi ab\,\hat{z}}} \equiv 2S\,\hat{z}$$

↳ Area of the ellipse: $\underline{\underline{\pi ab}}$.

(4) 1.13 4 $\quad \vec{F} = -\vec{\nabla}\phi \quad$ or

$$\begin{cases} -\dfrac{\partial}{\partial x}\phi = -GMm\dfrac{x}{R^3}, & \Rightarrow \phi = \displaystyle\int dx\, GMm\frac{x}{R^3} = \frac{GMm\,x^2}{2R^3} \\[2ex] -\dfrac{\partial}{\partial y}\phi = -GMm\dfrac{y}{R^3}, & \text{— " —} \\[2ex] -\dfrac{\partial}{\partial z}\phi = +2GMm\dfrac{z}{R^3}. & \text{— " —} \end{cases}$$

add them up:

$$\boxed{\phi = \frac{GMm}{2R^3}(x^2+y^2-z^2) + \cancel{\text{const}}.}$$

0, take $\phi(0)$