# 2013 Mathematics (2)



## Section A

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# Section B

## 11S

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## 12W

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## 13X

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## 14Z

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## 15T

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## 16R

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## 17Y

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### *Solution(s):*

From user: ar857

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because dU is exace mixed ~~differen~~ partial derivatives must be equal

$$dU = TdS - pdV$$

$$T = \left(\frac{\partial U}{\partial S}\right)_V \qquad -p = \left(\frac{\partial U}{\partial V}\right)_S$$

$$\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial p}{\partial S}\right)_V$$

a) ① $H = U + pV$

$$dH = TdS + Vdp \qquad \left(\frac{\partial T}{\partial p}\right)_S = \left(\frac{\partial V}{\partial S}\right)_p$$

② $dG = \cancel{-}TdS + pdV + pdV + Vdp - TdS - SdT = Vdp - SdT$

$$\left(\frac{\partial V}{\partial T}\right)_p = -\left(\frac{\partial S}{\partial p}\right)_T$$

③ $dF = TdS - pdV - TdS - SdT = -pdV - SdT$

$$\left(\frac{\partial p}{\partial T}\right)_V = \left(\frac{\partial S}{\partial V}\right)_T$$

b) $$\left(\frac{\partial U}{\partial V}\right)_T = \left(\frac{\partial U}{\partial S}\right)_V\left(\frac{\partial S}{\partial V}\right)_T + \left(\frac{\partial U}{\partial V}\right)_S\left(\frac{\partial V}{\partial V}\right)_T = T\left(\frac{\partial p}{\partial T}\right)_V - p$$

$$p = \frac{RT}{V-b} - \frac{a}{V^2}$$

$$\left(\frac{\partial U}{\partial V}\right)_T = T\frac{R}{V-b} - \frac{RT}{V-b} + \frac{a}{V^2} = \frac{a}{V^2}$$

$$U = -\frac{a}{V} + cT$$

## 18T

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## 19R*

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## 20Z*

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