SEMPER UBI SUB UBI

EXAMINATIONS — 2023
TRIMESTER 2
FRONT PAGE

MURPH101

SCIENTIFIC BASIS OF MURPHY'S LAWS

AUGUST 03, 2023

Time allowed: **THREE HOURS**

Permitted materials: **OPEN BOOK**
Any materials except communication via electronic devices.

Instructions: Attempt ALL **5** questions

The exam will be marked out of a total of **20** marks.

You can use the formulas listed at the end without rederiving them, unless explicitly requested.

PART 1

In multiple-choice questions, briefly justify your answer if unsure. On second thought, scratch that — rewrite the question if you find it makes no sense. ¯_(ツ)_/¯

1. In the context of dermodynamics, point your finger at the true statement(s). **[8 marks]**

(a) The first law of dermodynamics states that fingerprints can only be transferred.

(b) The second law of dermodynamics states that fingerprints tend to appear on shiny surfaces.

(c) The third law of dermodynamics states that wrinkles always in-crease in a bath tub.

(d) The zeroth law of dermodynamics nails down the concept of absolute zero.

2. Explain the concept of quantum tunneling in the context of pub physics. Provide an equation and discuss the factors that influence the probability of quantum tunneling in a half-full / half-empty pint. Would you bet that the pint circumference is greater than π? **[5 marks]**

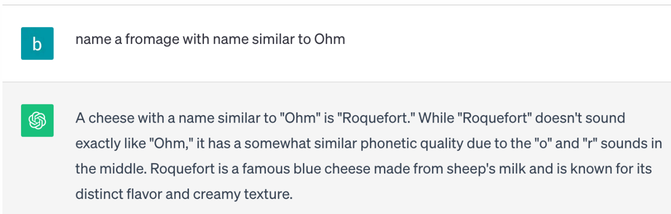
3. What is the *Système International* unit of cheese (F)? **[1 mark]**

(a) Coulommiers (C)

(b) Tome (Ω)

(c) Vieux pané (V)

(d) Aiguille d'Orcières (A)



4. Describe the *German Specialty* principle which A. Einstein described in a famous baking textbook, introducing the equation

$$E = mc^2$$

that has revolutionised our understanding of fast food. Provide examples of its applications in the theory of black ovens. Is the cake in the oven when no-one is watching? **[8 marks]**

5. Ray was arrested by Alice and Bob and is trapped under total internal incarceration. Which of the following phenomena is responsible for the change in Ray's trajectory, and ultimate rehabilitation from the darkness whence Ray came? **[0.2 mark]**

(a) Retraction

(b) Deflexion
  (i) Ray's
  (ii) Someone else's

(c) Superstition

(d) Infraction

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APPENDIX

Vector calculus identities

$\nabla(fg) = f\nabla g + g\nabla f$

$\nabla(\boldsymbol{A}\cdot\boldsymbol{B}) = \boldsymbol{A}\times(\nabla\times\boldsymbol{B}) + \boldsymbol{B}\times(\nabla\times\boldsymbol{A}) + (\boldsymbol{A}\cdot\nabla)\boldsymbol{B} + (\boldsymbol{B}\cdot\nabla)\boldsymbol{A}$

$\nabla\cdot(f\boldsymbol{A}) = f(\nabla\cdot\boldsymbol{A}) + \boldsymbol{A}\cdot(\nabla f)$

$\nabla\cdot(\boldsymbol{A}\times\boldsymbol{B}) = \boldsymbol{B}\cdot(\nabla\times\boldsymbol{A}) - \boldsymbol{A}\cdot(\nabla\times\boldsymbol{B})$

$\nabla\times(f\boldsymbol{A}) = f(\nabla\times\boldsymbol{A}) - \boldsymbol{A}\times(\nabla f)$

$\nabla\times(\boldsymbol{A}\times\boldsymbol{B}) = (\boldsymbol{B}\cdot\nabla)\boldsymbol{A} - (\boldsymbol{A}\cdot\nabla)\boldsymbol{B} + (\nabla\cdot\boldsymbol{B})\boldsymbol{A} - (\nabla\cdot\boldsymbol{A})\boldsymbol{B}$

Cylindrical coordinates:

$x = s\cos\varphi$
$y = s\sin\varphi$
$z = z$

$$\nabla f = \frac{\partial f}{\partial s}\hat{\boldsymbol{s}} + \frac{1}{s}\frac{\partial f}{\partial\varphi}\hat{\boldsymbol{\varphi}} + \frac{\partial f}{\partial z}\hat{\boldsymbol{z}}$$

$$\nabla\cdot\boldsymbol{A} = \frac{1}{s}\frac{\partial}{\partial s}(sA_s) + \frac{1}{s}\frac{\partial A_\varphi}{\partial\varphi} + \frac{\partial A_z}{\partial z}$$

$$\nabla\times\boldsymbol{A} = \left(\frac{1}{s}\frac{\partial A_z}{\partial\varphi} - \frac{\partial A_\varphi}{\partial z}\right)\hat{\boldsymbol{s}} + \left(\frac{\partial A_s}{\partial z} - \frac{\partial A_z}{\partial s}\right)\hat{\boldsymbol{\varphi}} + \frac{1}{s}\left(\frac{\partial}{\partial s}\left(sA_\varphi\right) - \frac{\partial A_s}{\partial\varphi}\right)\hat{\boldsymbol{z}}$$

$$\nabla^2 f = \frac{1}{s}\frac{\partial}{\partial s}\left(s\frac{\partial f}{\partial s}\right) + \frac{1}{s^2}\frac{\partial^2 f}{\partial\varphi^2} + \frac{\partial^2 f}{\partial z^2}$$

Spherical coordinates:

$x = r\sin\theta\cos\varphi$

$y = r\sin\theta\sin\varphi$

$z = r\cos\theta$

$$
\begin{aligned}
\nabla f &= \frac{\partial f}{\partial r}\hat{\boldsymbol{r}} + \frac{1}{r}\frac{\partial f}{\partial \theta}\hat{\boldsymbol{\theta}} + \frac{1}{r\sin\theta}\frac{\partial f}{\partial \varphi}\hat{\boldsymbol{\varphi}} \\
\nabla \cdot \boldsymbol{A} &= \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 A_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta A_\theta) + \frac{1}{r\sin\theta}\frac{\partial A_\varphi}{\partial \varphi} \\
\nabla \times \boldsymbol{A} &= \frac{1}{r\sin\theta}\left(\frac{\partial}{\partial \theta}\left(A_\varphi \sin\theta\right) - \frac{\partial A_\theta}{\partial \varphi}\right)\hat{\boldsymbol{r}} \\
&\quad + \frac{1}{r}\left(\frac{1}{\sin\theta}\frac{\partial A_r}{\partial \varphi} - \frac{\partial}{\partial r}\left(r A_\varphi\right)\right)\hat{\boldsymbol{\theta}} \\
&\quad + \frac{1}{r}\left(\frac{\partial}{\partial r}(r A_\theta) - \frac{\partial A_r}{\partial \theta}\right)\hat{\boldsymbol{\varphi}} \\
\nabla^2 f &= \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 \frac{\partial f}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta \frac{\partial f}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 f}{\partial \varphi^2}
\end{aligned}
$$