



**EXAMINATIONS — 2023
TRIMESTER 2
FRONT PAGE**

**MUR_{PH}101
SCIENTIFIC BASIS OF MUR_{PH}'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 increase 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)

b

name a fromage with name similar to Ohm



A cheese with a name similar to "Ohm" is "Roquefort." While "Roquefort" doesn't sound exactly like "Ohm," it has a somewhat similar phonetic quality due to the "o" and "r" sounds in the middle. Roquefort is a famous blue cheese made from sheep's milk and is known for its distinct flavor and creamy texture.

4. Describe the principle of German specialty attributed to a *gedanken experiment* about Albert Einstein writing a famous baking textbook. Explain the meaning of the equation $E = mc^2$ and how it 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

APPENDIX

Vector calculus identities

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

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

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

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

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

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

Cylindrical coordinates:

$$x = s \cos \varphi$$

$$y = s \sin \varphi$$

$$z = z$$

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

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

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

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

Spherical coordinates:

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

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

$$z = r \cos \theta$$

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