• Planets: 2017/8 – Q 3. ii)

Moon mag field = 72 mT 5.5×10^{-16}
Earth mag field = 25 – 65 μT

why these readings?

this is wrong earth's is bigger!

• Planets: 2017/8 – Q 4. a) + full ex (I cannot figure it out '')

$I = \int dJ = \int_0 r^2\, dm$ $I = \frac{8}{15}\rho\pi R^5$ here?

$J = \frac{2}{3}MR^2 \therefore M = \frac{4}{3}\rho\pi R^3$?? is this right – if not how do U get

• Planets: 2017/8 – Q5 a) $\Gamma_d = -\frac{\Delta T}{\Delta z} = \frac{g}{?}$: Lapse rate

$t = \sqrt{\frac{2\times d}{g}}$

b) c_p? $= -\frac{0.29}{3000} = 9.7\times10^{-5} = \frac{g}{c_p}$

$\frac{c}{g} =$ ... u need to know this to solve it!

17/18: 6 a) depth $= \frac{\pi R_E^2}{\pi R_S^2}$

Rate of dist or Lapse rate

echo = 2 way travel time

geol ... and [~ S I C]

Practice (est)

• Planets: How do I measure residual? ← 2017/18 : Q6 → ...° depth transit

If U do not see a planet in transit can U measure it's atmosphere? ~ I assume not

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• Maths: Q6 2017/18: a–b Loadwork : check with ...

6. (a) From the integral definition of divergence it follows that for any well-behaved scalar field T, $\nabla^2 T = \nabla\cdot\nabla T = \lim_{V\to 0}\frac{1}{V}\oint_S \nabla T\cdot d\mathbf{S}$.

(i) Interpret the terms V, S and $d\mathbf{S}$ in this expression. (2)

(ii) Use the expression to explain what $\nabla^2 T$ measures, and why it appears in so many equations of science. (4)

(b) (i) Why are Gauss' Divergence Theorem and Stokes' Theorem so useful in the derivation of equations of science? (2)

(ii) From thermodynamics, heat flux $\mathbf{H} = -\kappa\nabla T$ (κ = thermal conductivity, T = temperature). The rate of change of heat content per unit volume $= \rho C\frac{\partial T}{\partial t}$ (ρ = density, C = specific heat capacity, t = time). Use these facts, plus the conservation of energy, to derive a differential equation for the temperature $T(\mathbf{r},t)$ in a given region of space and time. (4)

?

$\vec{H} = -k\nabla T$

rate chge $= \rho c\frac{\partial T}{\partial t}$

... not sure

$(AB)^T = B^T A^T$

• Maths: Q9 2020/21:

Matrices A and B satisfy the equation
$(AB)^T + B^{-1}A = 0$.
If B is orthogonal, show that A is antisymmetric.

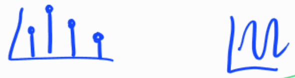
hand form

• Maths: b) Q2 2018/19

a) $g(t) = 1 + \sum_{\substack{n=-\infty \\ n\neq 0}}^{\infty} \frac{1}{n\pi} e^{\frac{in\pi}{2}} e^{\frac{in\pi}{2}t}$

$\omega_0 = \pi/2$ $T = 4$

b) Plot amplitude & spectra?



p21 notes part 1

• Maths: Q3 d) 2018/19: $F_q(\omega) = \sin(3\omega)$

Symmetry: $2\pi g(-\omega) \xrightarrow{\text{IFT}} G(t)$

$\frac{\sin(\omega_0 t)}{\pi t} \xrightarrow{\text{FT}} H(\omega+\omega_0) - H(\omega-\omega_0)$

$F = \frac{1}{3\pi}F_q = \frac{\sin(3t)}{\pi t} \therefore \omega_0 = 3 \xrightarrow{\text{FT}} (H(\omega+3) - H(\omega-3))\frac{1}{3\pi}$

$2\pi F \xrightarrow{\text{IFT}} \frac{2}{3}(H(\omega+3) - H(\omega-3))$ $\frac{i}{2}[\delta(t-3) - \delta(t+3)]$

circle BC start = end

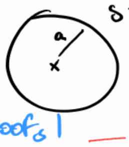
• Maths: Q5 2018/19 – Separation of var are scary FULL Qst°

could cross-ref before tutorial 1st

• ~~Maths: Q6 2018/19 – recurrence relat° stuff~~

~~b)~~

• Maths: Q7 2018/19



S: $\Phi = V_0\cos^3(\theta)$

$r > a$: Φ ?

Laplace: $\Psi = (Ar^{l} + Br^{-(l+1)})P_l^m(\cos\theta)(C\cos(m\phi) + D\sin(m\phi))$

– cross reference with her notes

v never have ϕ dependence

• Maths: Q8 2018/19 – proofs! – p 301

b) observables are real

• EM 2019/20 Q5 a) $c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$

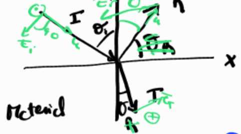
z

why switch to current density? – it looks like it should be an I

it is an I

• EM is this right: Air

2017/18 Q8 a)



+ indicate wavevectors

+ field (B & E)

honestly worth doing this qst° in full - all details θ

8. An electromagnetic wave propagating in air hits a surface of a material. Part of the wave is reflected and part of it propagates inside the material.

(a) Draw a diagram showing the incident, reflected and transmitted waves for a general incidence angle θ, $0 < \theta < 90°$. Indicate directions of the wave vectors for all the waves, as well as the electric and magnetic fields assuming that the electric field oscillates in the plane of incidence. Also mark the angles of incidence, reflection and transmission. (4)

(b) Write down the boundary condition for the electric field at the surface of the material in terms of the amplitudes of the incoming wave, E_i, reflected wave, E_r, and transmitted wave, E_t, and the angles of incidence and transmission. (3)

(c) For the part of the wave that passed through the surface into the material, what is the impact of non-zero conductivity of that material on its propagation? (1)

(d) The loss tangent of the material at frequency $f_1 = 3$ GHz is equal to 0.1 and its dielectric constant $\epsilon_r = 4$.

(i) Estimate for what frequencies the material can be treated as a good conductor. $f < \sim 3 \times 10^8$ Hz (2)

(ii) Assuming the material is non-magnetic, estimate the depth from the surface at which the amplitude of the electric field of the transmitted wave with frequency f_1 will decay to one tenth of its original value. 0.37m (3)

(e) Consider again the surface between the air and the material. Because the material is non-magnetic, the Fresnel reflection and transmission coefficients are given by

$$r_\parallel = \frac{\sin 2\theta_t - \sin 2\theta_i}{\sin 2\theta_t + \sin 2\theta_i}, \quad t_\parallel = \frac{4 \sin\theta_t \cos\theta_i}{\sin 2\theta_t + \sin 2\theta_i},$$

$$r_\perp = \frac{\sin(\theta_t - \theta_i)}{\sin(\theta_t + \theta_i)}, \quad t_\perp = \frac{2 \sin\theta_t \cos\theta_i}{\sin(\theta_t + \theta_i)},$$

where θ_i and θ_t are the angles of incidence and transmission, respectively, and $\perp$ and $\parallel$ refer to perpendicular and parallel polarization of the electric field with respect to the plane of incidence. Using these equations, explain how a boundary between two media can be used to polarize an electromagnetic wave. (2)