

Please check the examination details below before entering your candidate information

Candidate surname	Other names					
Pearson Edexcel International Advanced Level	Centre Number <table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 20px; height: 20px;"></td> </tr> </table>					
Candidate Number <table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 20px; height: 20px;"></td> </tr> </table>						
Wednesday 22 May 2019						
Afternoon (Time: 1 hour 20 minutes)	Paper Reference WPH06/01					
Physics Advanced Unit 6: Experimental Physics						
You must have: Ruler	Total Marks 					

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 40.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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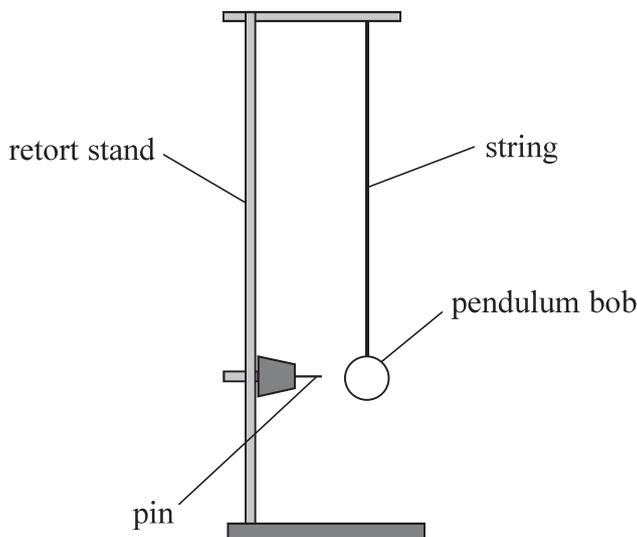
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Answer ALL questions. Write your answers in the spaces provided.

- 1 A student investigated how the time period T of a simple pendulum varies with the length l of the pendulum, using the apparatus shown.



The pendulum performs simple harmonic motion, hence T is given by the equation

$$T = 2\pi\sqrt{\frac{l}{g}}$$

The student displaced the pendulum bob by a small distance to set the pendulum oscillating. The student measured the time for 10 complete oscillations.

- (a) (i) State the reason for using a small displacement.

(1)

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- (ii) The student used a pin as a timing marker.

Explain how placing the pin at the centre of oscillation would lead to a more accurate value for $10T$.

(2)

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(b) The student obtained the following results.

$10T/s$	$10T/s$	$10T/s$	$10T/s$	$10T/s$	mean $10T/s$	mean T/s
10.15	10.32	10.20	10.28	10.24		

(i) Complete the table. (2)

(ii) Calculate the percentage uncertainty in T . (2)

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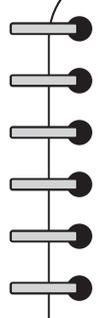
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Percentage uncertainty =

(c) The student doubled the length of the pendulum. She made the following prediction.



Prediction:
 If time period for short pendulum = T_s
 and time period for double length = T_d
 Then T_d^2 / T_s^2 should be 2

(i) Justify the prediction. (2)

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(ii) The student determines T for the longer pendulum as 1.461 ± 0.011 s.

Determine whether her results support her prediction.

(4)

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(Total for Question 1 = 13 marks)

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2 An alternating current in a primary coil generates a magnetic field. This induces an e.m.f. across a small secondary coil placed in the magnetic field.

(a) Explain how an e.m.f. is induced across the secondary coil.

(2)

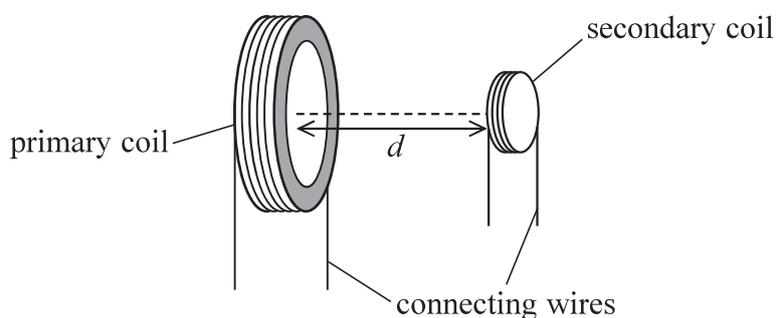
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(b) A student has the apparatus shown.



The e.m.f. V induced across the secondary coil is given by

$$V = \frac{kNI}{d^3}$$

where

k is a constant,

N is the number of turns on the primary coil,

I is the current in the primary coil,

d is the distance between the centres of the coils as shown.

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The student investigates how V varies with d .

Write a plan to determine k using a graphical method.

Your plan should include:

- (i) a circuit diagram to show how the primary coil should be connected with any additional components required, (1)
- (ii) the measurements to be made with any additional apparatus required, (3)
- (iii) the graph to be plotted and how it would be used to determine k , (2)
- (iv) a statement of a significant source of uncertainty. (1)

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(Total for Question 2 = 9 marks)



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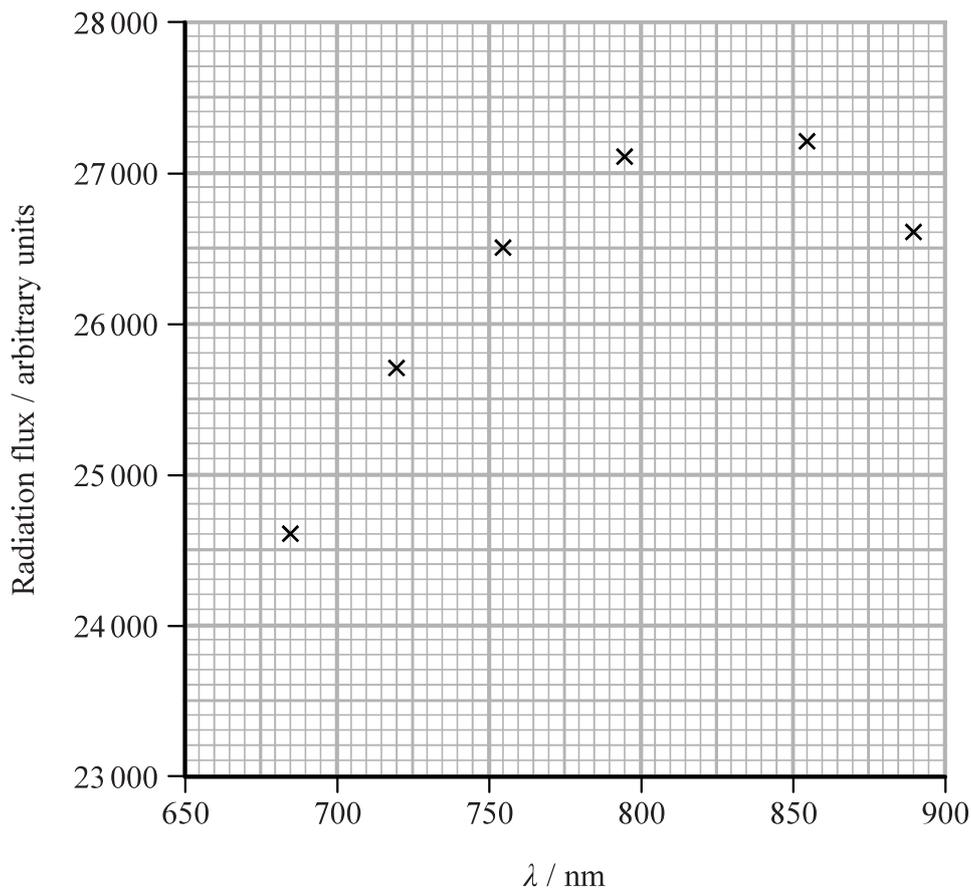
- 3 The surface temperature T of a star can be estimated by determining the wavelength λ_{max} at which peak power emission occurs from the star.

A student astronomer observed the red giant Betelgeuse.

He measured the radiation flux at six wavelengths and obtained the following results.

Radiation flux / arbitrary units	λ / nm
24 600	685
25 700	720
26 500	755
27 100	795
27 200	855
26 600	890

The data was plotted as shown.



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(a) (i) Draw a line of best fit to show where the radiation flux is a maximum. (2)

(ii) Estimate λ_{max} . (1)

$\lambda_{\text{max}} = \dots\dots\dots$

(iii) Calculate a value for T . (2)

$T = \dots\dots\dots$

(b) Suggest two reasons why the value of λ_{max} might not be accurate. (2)

(Total for Question 3 = 7 marks)



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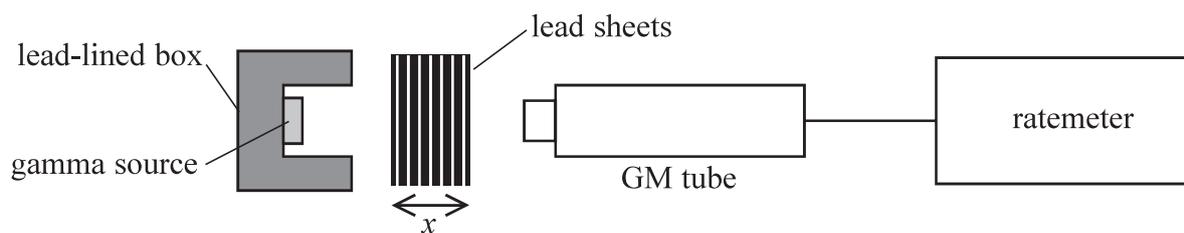


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- 4 A student investigated the absorption of gamma radiation by lead, using the apparatus shown.



- (a) She recorded and corrected for the background count rate.

Explain why it is possible to correct for background count rate.

(2)

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- (b) The student recorded the corrected count rate C with different thicknesses of lead sheets.

The relationship between C and the total thickness x of the lead sheets is

$$C = C_0 e^{-\mu x}$$

where C_0 is the count rate without any lead sheets and μ is a constant.

Explain why plotting a graph of $\ln C$ against x will produce a straight line.

(2)

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(c) The student obtained the following results.

x / mm	C / s^{-1}	
1.52	132	
3.89	112	
6.81	95	
9.33	86	
11.48	74	
13.70	67	

(i) Plot a graph of $\ln C$ against x on the grid provided. Use the additional column in the results table to record your processed data.

(5)

(ii) Determine a value for μ .

(2)

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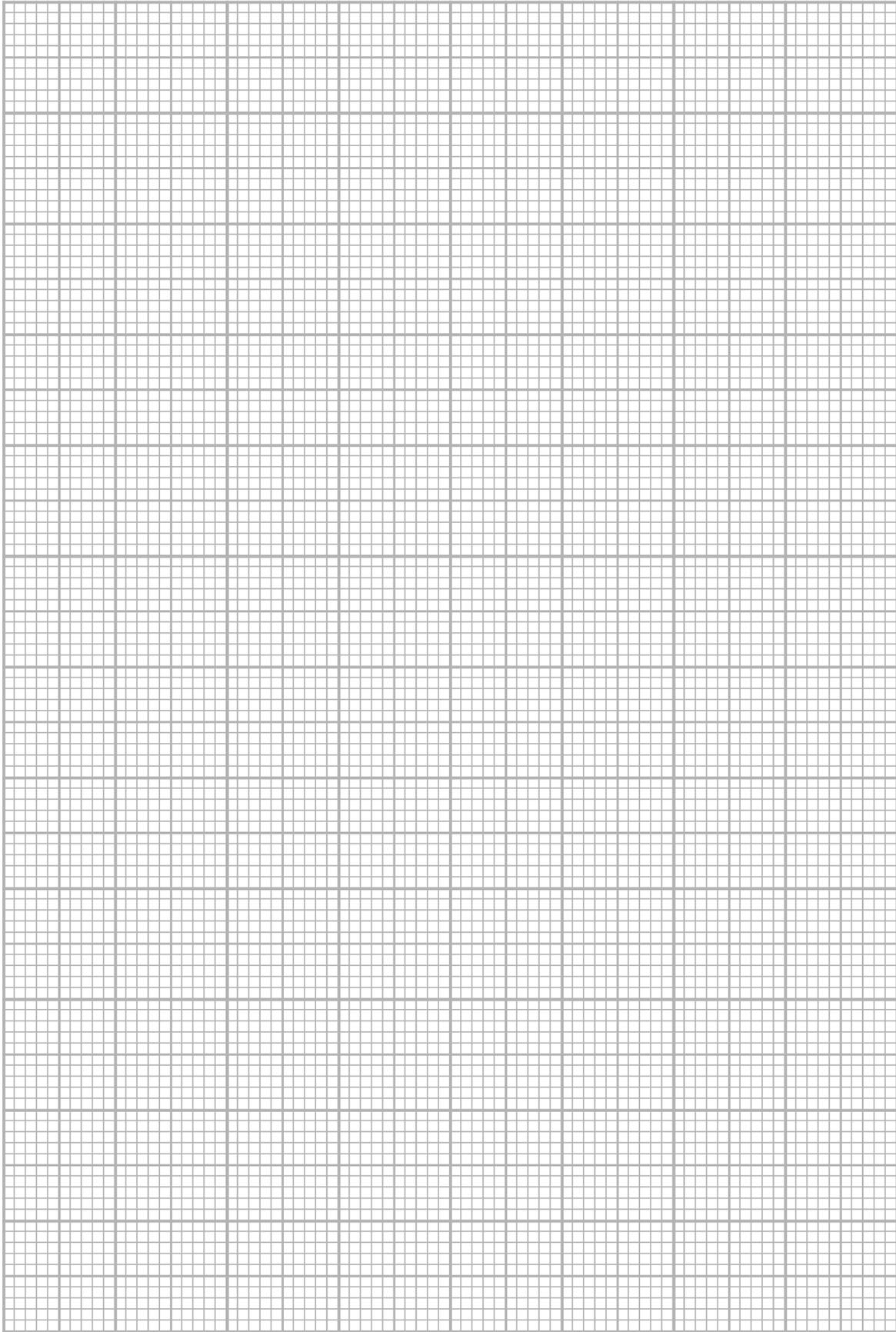
$\mu =$



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(Total for Question 4 = 11 marks)

TOTAL FOR PAPER = 40 MARKS



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List of data, formulae and relationships

Acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\epsilon_0$ $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	
Electron charge	$e = -1.60 \times 10^{-19} \text{ C}$	
Electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$	
Electronvolt	$1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$	
Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27} \text{ kg}$	

Unit 1*Mechanics*

Kinematic equations of motion	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
Forces	$\Sigma F = ma$ $g = F/m$ $W = mg$
Work and energy	$\Delta W = F\Delta s$ $E_k = \frac{1}{2}mv^2$ $\Delta E_{\text{grav}} = mg\Delta h$

Materials

Stokes' law	$F = 6\pi\eta rv$
Hooke's law	$F = k\Delta x$
Density	$\rho = m/V$
Pressure	$p = F/A$
Young modulus	$E = \sigma/\epsilon$ where Stress $\sigma = F/A$ Strain $\epsilon = \Delta x/x$
Elastic strain energy	$E_{\text{el}} = \frac{1}{2}F\Delta x$

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Unit 2*Waves*

Wave speed

$$v = f\lambda$$

Refractive index

$${}_1\mu_2 = \sin i / \sin r = v_1 / v_2$$

Electricity

Potential difference

$$V = W/Q$$

Resistance

$$R = V/I$$

Electrical power, energy and efficiency

$$P = VI$$

$$P = I^2R$$

$$P = V^2/R$$

$$W = VIt$$

$$\% \text{ efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100$$

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

Resistivity

$$R = \rho l/A$$

Current

$$I = \Delta Q / \Delta t$$

$$I = nqvA$$

Resistors in series

$$R = R_1 + R_2 + R_3$$

Resistors in parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Quantum physics

Photon model

$$E = hf$$

Einstein's photoelectric equation

$$hf = \phi + \frac{1}{2}mv_{\max}^2$$

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Unit 4*Mechanics*

Momentum

$$p = mv$$

Kinetic energy of a non-relativistic particle

$$E_k = p^2/2m$$

Motion in a circle

$$v = \omega r$$

$$T = 2\pi/\omega$$

$$F = ma = mv^2/r$$

$$a = v^2/r$$

$$a = r\omega^2$$

Fields

Coulomb's law

$$F = kQ_1Q_2/r^2 \text{ where } k = 1/4\pi\epsilon_0$$

Electric field

$$E = F/Q$$

$$E = kQ/r^2$$

$$E = V/d$$

Capacitance

$$C = Q/V$$

Energy stored in capacitor

$$W = \frac{1}{2}QV$$

Capacitor discharge

$$Q = Q_0 e^{-t/RC}$$

In a magnetic field

$$F = BIl \sin \theta$$

$$F = Bqv \sin \theta$$

$$r = p/BQ$$

Faraday's and Lenz's laws

$$\epsilon = -d(N\phi)/dt$$

Particle physics

Mass-energy

$$\Delta E = c^2 \Delta m$$

de Broglie wavelength

$$\lambda = h/p$$

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Unit 5*Energy and matter*

Heating $\Delta E = mc\Delta\theta$

Molecular kinetic theory $\frac{1}{2}m\langle c^2 \rangle = \frac{3}{2}kT$

Ideal gas equation $pV = NkT$

Nuclear Physics

Radioactive decay $dN/dt = -\lambda N$

$$\lambda = \ln 2/t_{1/2}$$

$$N = N_0 e^{-\lambda t}$$

Mechanics

Simple harmonic motion

$$a = -\omega^2 x$$

$$a = -A\omega^2 \cos \omega t$$

$$v = -A\omega \sin \omega t$$

$$x = A \cos \omega t$$

$$T = 1/f = 2\pi/\omega$$

Gravitational force $F = Gm_1 m_2 / r^2$

Observing the universe

Radiant energy flux $F = L/4\pi d^2$

Stefan-Boltzmann law

$$L = \sigma T^4 A$$

$$L = 4\pi r^2 \sigma T^4$$

Wien's law $\lambda_{\max} T = 2.898 \times 10^{-3} \text{ m K}$

Redshift of electromagnetic radiation $z = \Delta\lambda/\lambda \approx \Delta f/f \approx v/c$

Cosmological expansion $v = H_0 d$

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