

Write your name here

Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Physics

Advanced

Unit 6: Experimental Physics

Thursday 14 May 2015 – Afternoon

Time: 1 hour 20 minutes

Paper Reference

WPH06/01

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.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Answer ALL questions in the spaces provided.

- 1** A student was asked to determine the density of the metal from which a food can is made.



- (a) She calculated the volume of the metal by determining the external volume of the can and subtracting the internal volume.

- (i) She measured the external height of the can using a metre rule.

State the precision of a metre rule.

(1)

- (ii) She used two set squares and a metre rule to measure the external diameter of the can.

Describe how you would use this apparatus to measure accurately the diameter of a can. Your description should include a diagram.

(2)



(b) The student recorded the following results.

Quantity	Measurements	Mean value
Internal volume / cm ³	391 399 398	396
Height / cm	10.1 10.1 10.1	10.1
External diameter / cm	7.2 7.1 7.3	7.2
Mass / kg	4.982×10^{-2}	

The volume of a cylinder is given by $V = \pi r^2 h$

where r is the radius of the cylinder and h is its height.

(i) Use these measurements to show that the external volume is about 400 cm³.

(1)

(ii) Hence calculate a value for the volume of the metal.

(1)

Volume of metal = ...

(iii) Hence calculate a value for the density of the metal.

(2)

Density of metal = ...



- (c) (i) Use the measurements to estimate the percentage uncertainty in the external volume. You should assume the uncertainty in the height measurement is negligible.

(2)

.....

.....

.....

.....

Percentage uncertainty = ... %

- (ii) Use the measurements to estimate the percentage uncertainty in the internal volume.

(1)

.....

.....

Percentage uncertainty = ... %

- (iii) The volume of metal was determined by subtracting the internal volume of the can from the external volume. This produces a percentage uncertainty for the volume of metal which is greater than 10%.

Suggest why.

(1)

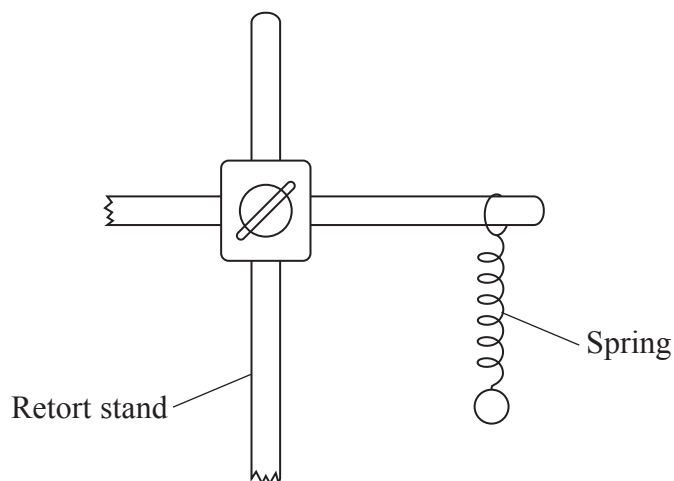
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(Total for Question 1 = 11 marks)



- 2 A student is asked to determine the spring constant for a small spring.



He has the following additional apparatus:

50 g mass hanger with 9×50 g masses

stopwatch with a precision of 0.01 s

optical pin.

He is told that the time period T for vertical oscillations of a mass m is

$$T = 2\pi\sqrt{\frac{m}{k}}$$

where k is the spring constant.

The student decides to determine the period of oscillation for different values of mass.

- (a) (i) Describe how he could make his readings for the time period as accurate as possible.

(2)

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- (ii) Describe the graph he should plot to obtain a straight line and how to determine the spring constant from the graph.

(3)

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- (b) His teacher suggests using a position sensor with a datalogger instead of the stopwatch.

- (i) Draw a diagram to show how this apparatus could be used to record the position of the hanging mass.

(2)

- (ii) Explain how using a position sensor with a datalogger will improve the measurement of the time period.

(2)

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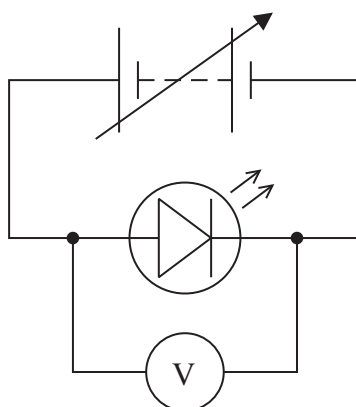
(Total for Question 2 = 9 marks)



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- 3 A student used light emitting diodes (LEDs) to determine a value for Planck's constant. He set up the circuit shown.



He increased the potential difference V from zero and recorded the value at which the LED just began to emit light. He repeated this for LEDs that emitted light of different, known frequencies f .

His results are shown in the table.

$f/\text{Hz} \times 10^{14}$	V/V
6.38	2.23
5.28	1.69
5.10	1.57
4.69	1.40

- (a) Criticise these results.

(1)

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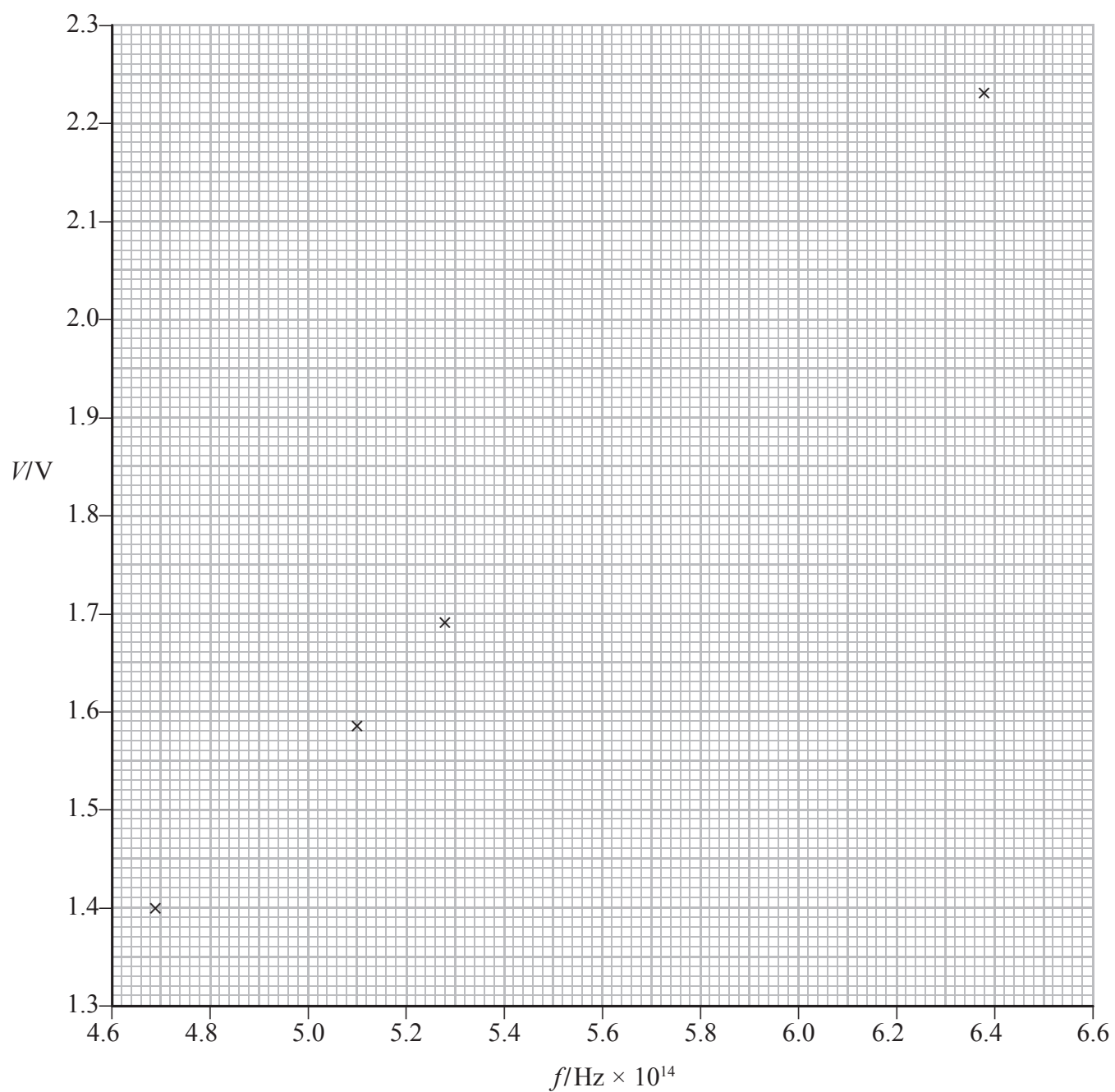


(b) V and f are related by

$$eV = hf - b$$

where e is the electron charge, h is Planck's constant and b is also a constant.

The student plotted a graph of V against f .



- (i) Draw a straight line of best fit on the graph.

(1)

- (ii) Use the gradient of your line to determine a value for Planck's constant.

(4)

Planck's constant = ...

- (iii) Determine the percentage difference between your value and the accepted value of Planck's constant.

(1)

(Total for Question 3 = 7 marks)



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4 The intensity of light emitted by a light bulb varies with the electrical power supplied.

- (a) Draw a circuit diagram of the circuit you would use to vary and determine the electrical power supplied to a bulb.

(2)

- (b) In an experiment, a second circuit containing a Light Dependent Resistor (LDR) is used to determine the intensity of the light emitted by the bulb as the power supplied is varied. The LDR is placed a certain distance away from the bulb.

- (i) State what happens to the resistance of an LDR as the light intensity falling on it increases.

(1)

- (ii) State why the distance between the LDR and the bulb should remain constant throughout the experiment.

(1)



(c) Values of power P and the corresponding light intensity I are shown in the table below.

$I/\text{W m}^{-2}$	P/W		
1900	20.47		
740	13.09		
425	11.09		
220	8.29		
123	6.37		
76	5.45		

It is suggested that I and P are related by

$$I = kP^x$$

where k and x are constants.

(i) Show that a graph of $\ln I$ against $\ln P$ should be a straight line.

(2)

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(ii) Use the grid opposite to plot a graph of $\ln I$ against $\ln P$. Use the column(s) in the table for your processed data.

(5)

(iii) Use your graph to determine a value for x .

(2)

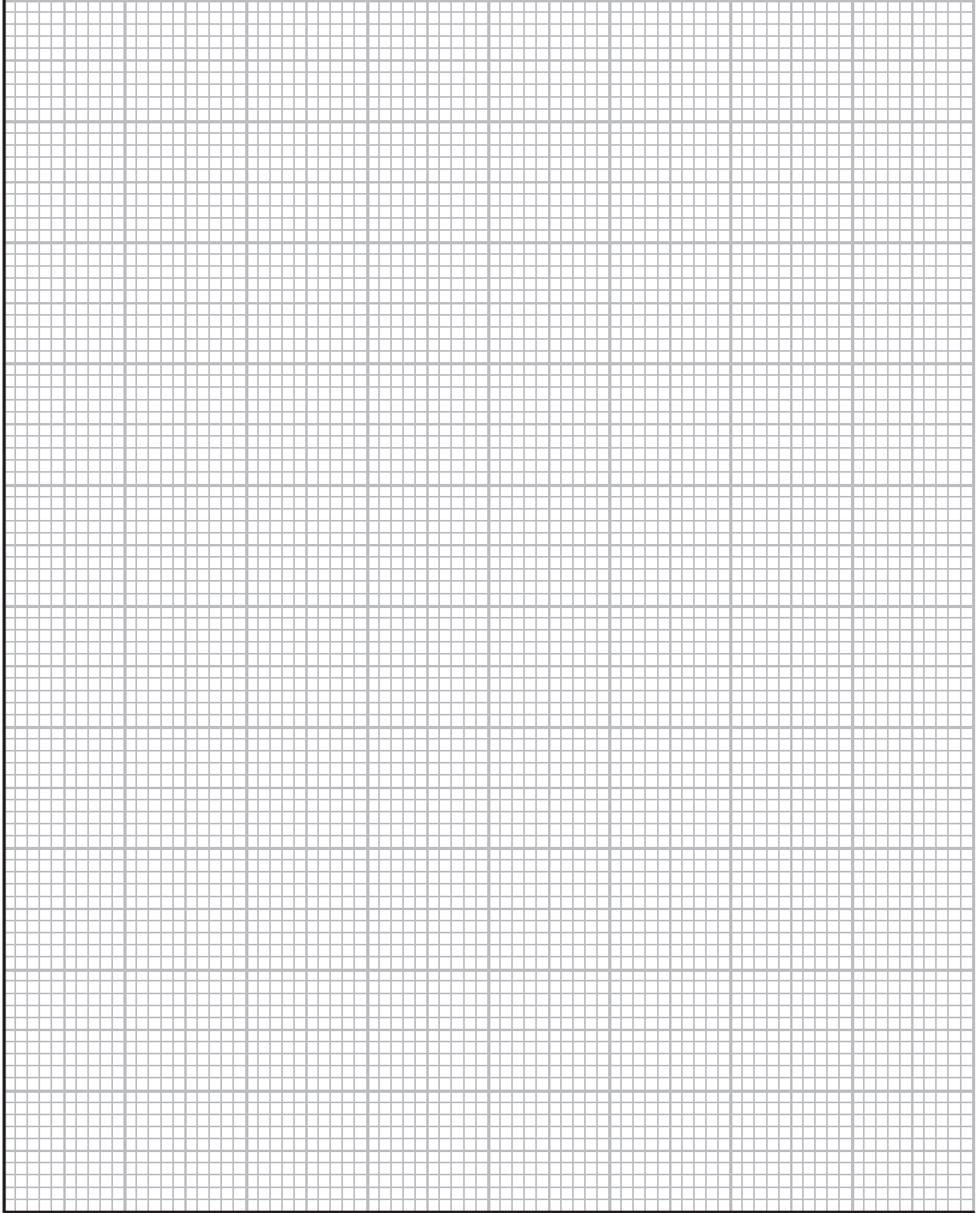
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$x =$





(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 40 MARKS



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	$E_{\text{el}} = \frac{1}{2}F\Delta x$



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

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



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	$F = kQ_1Q_2/r^2$ 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	$\lambda = h/p$



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	$F = Gm_1m_2/r^2$

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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