| Centre No. | | | | | | Paper Reference | Surname | Initial(s) |
|---|---|---|---|---|---|---|---|---|
| Candidate No. | | | | | | 6 7 3 4 / 0 1 | Signature | |

Paper Reference(s)

**6734/01**

# Edexcel GCE

## Physics

## Advanced Level

Unit Test PHY 4

Thursday 14 June 2007 – Morning

Time: 1 hour 20 minutes

Examiner's use only

Team Leader's use only

| Question Number | Leave Blank |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| Total | |

**Materials required for examination**
Nil

**Items included with question papers**
Nil

**Instructions to Candidates**

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Answer **ALL** questions in the spaces provided in this question paper.
In calculations you should show all the steps in your working, giving your answer at each stage.
Calculators may be used.
Include diagrams in your answers where these are helpful.

**Information for Candidates**

The marks for individual questions and the parts of questions are shown in round brackets.
There are eight questions in this paper. The total mark for this paper is 60.
**The list of data, formulae and relationships is printed at the end of this booklet.**

**Advice to Candidates**

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.



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N 2 6 1 4 7 A 0 1 2 0

***Turn over***

Leave blank

**1.** Add the correct words to complete the following word equations.

(i) Frequency = $\dfrac{\text{Wave speed}}{\text{..................................}}$

(ii) Wave intensity = $\dfrac{\text{Power}}{\text{..................................}}$

(iii) ........................................ = $\dfrac{\text{Recession speed of galaxy}}{\text{Distance of galaxy from the Earth}}$

(iv) Accelerating voltage = $\dfrac{\text{Kinetic energy gained by electron}}{\text{......................................................}}$

**Q1**

**(Total 4 marks)**

Leave blank

**2.** (a) Describe how you would demonstrate that light waves can be polarised. Include a diagram of the apparatus that you would use. Describe fully what you would observe.

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**(5)**

(b) State why it is not possible to polarise sound waves.

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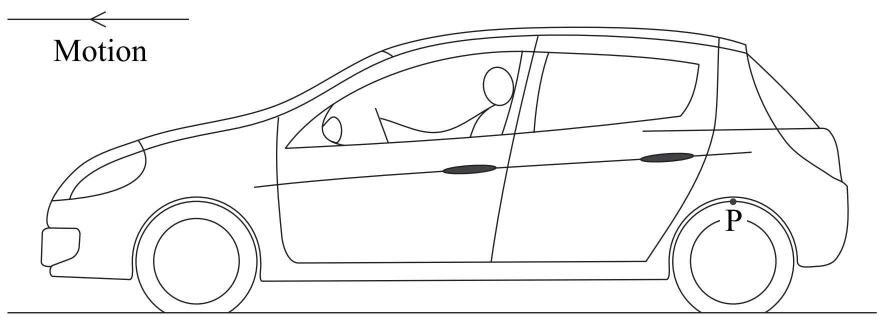
**(1)** **Q2**

**(Total 6 marks)**

Leave blank

**3.** The diagram shows a car travelling at constant velocity.




(a) P is a point on the rim of one of the rear wheels. Tick the **two** boxes in the table below which describe the motion of P at the instant shown.

| | To the left | Upwards | Downwards | Zero |
|---|---|---|---|---|
| Velocity of P | | | | |
| Acceleration of P | | | | |

**(2)**

(b) When the tyres are correctly inflated, the effective radius of each wheel is 28 cm. Calculate the period of rotation of the wheels when the car is travelling at 21 m s$^{-1}$.

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Period = ..............................................................

**(2)**

Leave blank

(c) (i) Low tyre pressures would reduce the effective radius of the wheels. Explain how this would change the angular speed of the wheels at a given road speed.

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**(1)**

(ii) The reading on the car's speedometer is determined by the frequency of rotation of the wheels, so it is accurate only if the tyres are correctly inflated. Explain whether the speedometer would read too high or too low if the tyre pressures were too low.

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**(1)**

**Q3**

**(Total 6 marks)**



N 2 6 1 4 7 A 0 5 2 0

**Turn over**

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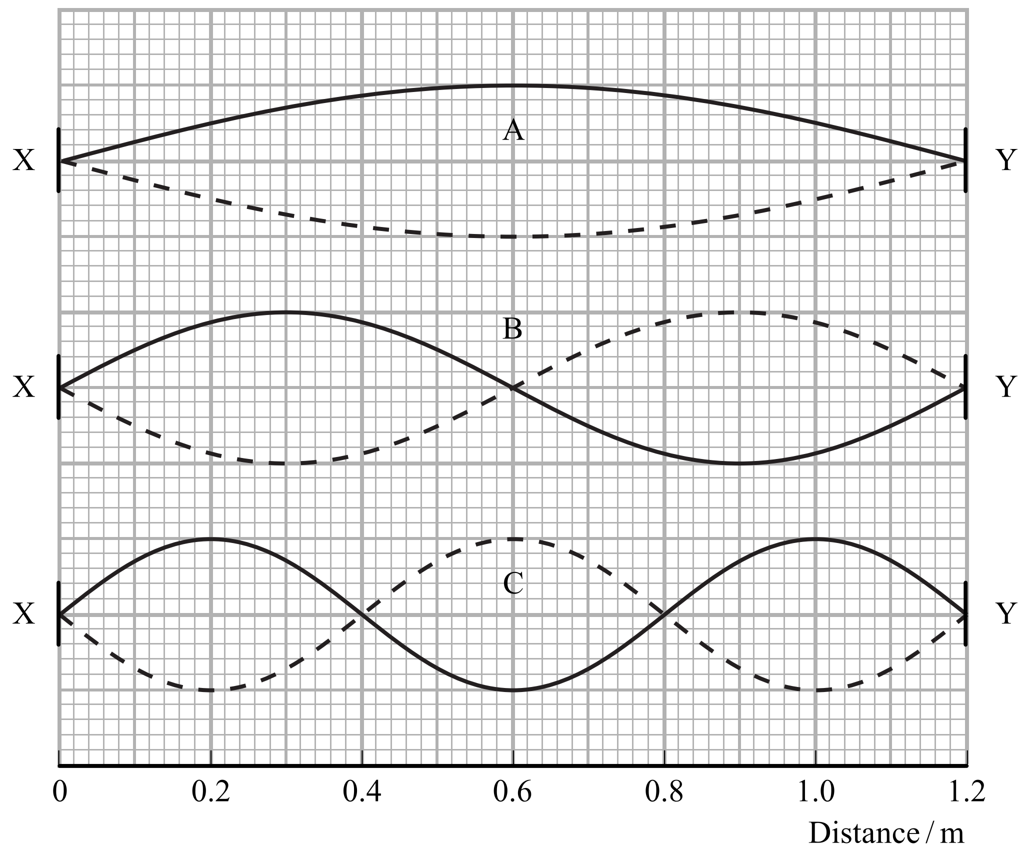
**4.** (a) The diagram shows three possible stationary waves on a string of length 1.20 m stretched between fixed points X and Y.




(i) Wave A has a frequency of 110 Hz.

Complete the table below to show the wavelengths and frequencies of the three waves.

| Wave | Wavelength / m | Frequency / Hz |
|---|---|---|
| A | | 110 |
| B | | |
| C | | |

**(3)**

(ii) Each of the waves has nodes at X and Y. Explain why these points must be nodes.

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**(1)**



N 2 6 1 4 7 A 0 6 2 0

Leave blank

(b) There is a similarity between the behaviour of the string in part (a) and that of the electron in a hydrogen atom. Electron states can be represented by stationary waves which have to fit inside the atom.

(i) Calculate the momentum of an electron whose de Broglie wavelength is $1.0 \times 10^{-10}$ m, similar to the size of an atom.

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Momentum = ....................................................

**(2)**

(ii) Stationary waves with greater numbers of nodes represent electrons in higher energy levels. Explain why this is the case.

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**(2)**

**Q4**

**(Total 8 marks)**

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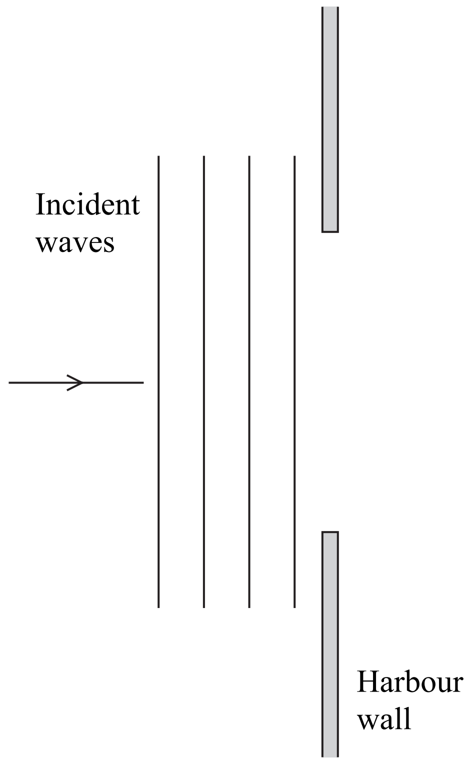
**5.** The diagram shows successive crests of sea waves approaching a harbour entrance.

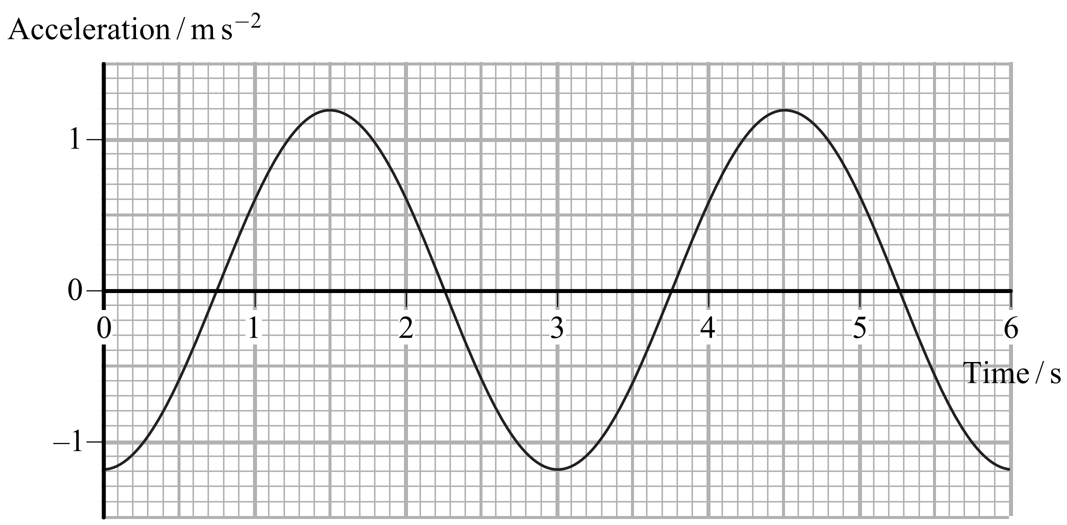



(a) Complete the diagram to show the pattern of waves you would expect to see inside the harbour.

**(3)**

(b) The waves are being studied by means of a buoy anchored in the harbour. As the waves pass the buoy they make it perform simple harmonic motion in the vertical direction. A sensor inside the buoy measures its acceleration.

The graph below shows how this acceleration varies with time.






N 2 6 1 4 7 A 0 8 2 0

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(i) State values for the period and maximum acceleration of the buoy.

Period = ............................................................................ s

Maximum acceleration = .......................................... $m\ s^{-2}$

**(1)**

(ii) Calculate the amplitude of oscillation of the buoy.

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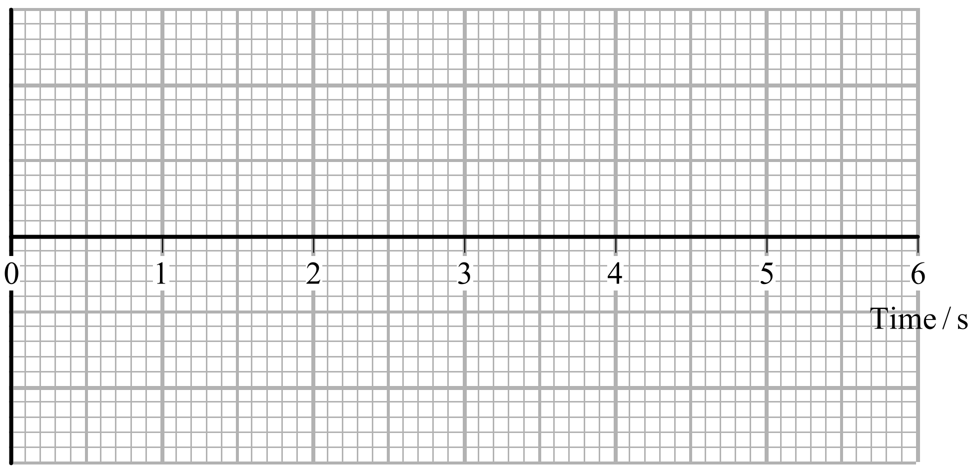
Amplitude = ......................................................................

**(3)**

(iii) On the grid below, sketch a graph of the displacement of the buoy against time, over the same interval of time as the acceleration graph.



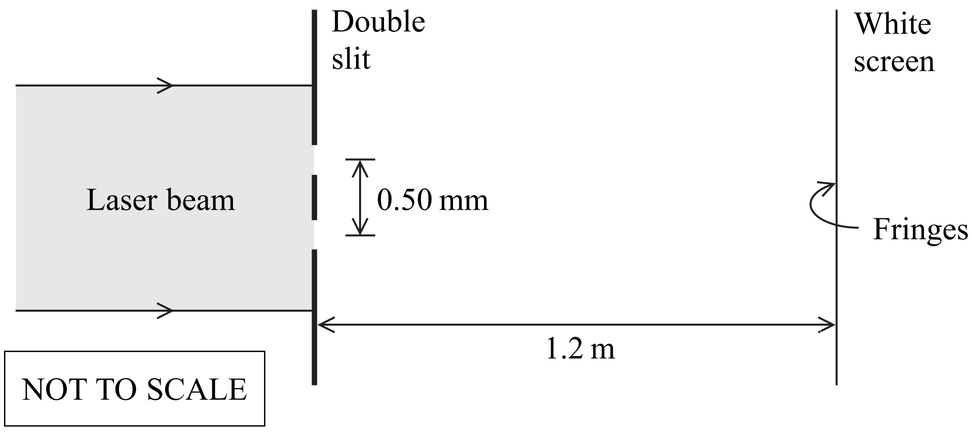

**(3)**

**Q5**

**(Total 10 marks)**

Leave blank

**6.** A beam of light from a laser is directed onto a pair of slits as shown.




The light from the slits superposes forming an interference pattern on the screen. For this arrangement the measured distance across 40 fringes is 49.6 mm.

(a) (i) Calculate the fringe width.

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Fringe width = ............................................

**(1)**

(ii) Calculate the wavelength of the light.

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Wavelength = ..............................................

**(2)**



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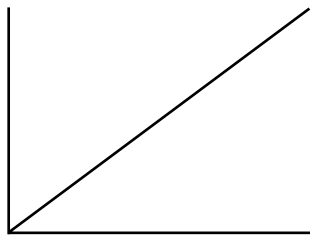
(b) When the distance between the slits and the screen is altered, the fringe width changes as shown on the graph.




Tick the appropriate boxes in the table below to show what would happen to the gradient of this graph if each change were made separately.

| Change | Effect on gradient | | |
|---|---|---|---|
| | Decreases | Unchanged | Increases |
| The laser is replaced by one emitting light of a shorter wavelength | | | |
| The slit separation is increased | | | |

**(2)**

(c) The two slits in this experiment act as coherent sources.

(i) State the meaning of the term **coherent**.

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**(1)**

(ii) It is impossible to observe interference between light beams from sources which are not coherent. Explain why.

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**(2)**

**Q6**

**(Total 8 marks)**

Leave blank

**7.** The table gives information about two beams of monochromatic light.

| | Intensity / W m$^{-2}$ | Colour |
|---|---|---|
| Beam A | 6.0 | red |
| Beam B | 0.2 | blue |

Each beam is shone in turn onto a barium plate. Beam B causes photoemission but beam A does not. A student says that this is because "the blue beam is more energetic than the red beam".

(a) In one sense the student's statement is correct. In another sense the statement is incorrect. Explain how it is:

**correct**

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**incorrect**

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(b) Barium has a work function of $3.98 \times 10^{-19}$ J.

(i) Explain the meaning of the term **work function**.

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**(2)**

(ii) Calculate the photoelectric threshold frequency for the barium plate.

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Threshold frequency = ......................................

**(2)**

**Q7**

**(Total 7 marks)**

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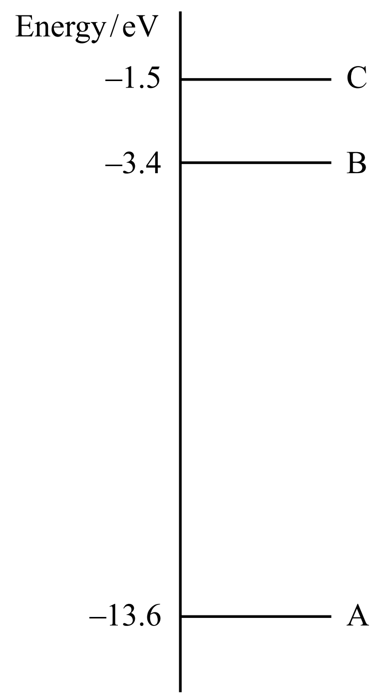
**8.** The diagram shows the lowest three energy levels of atomic hydrogen.




(a) Excited hydrogen atoms can emit light of wavelength 656 nm. By means of a suitable calculation, determine which transition between energy levels is responsible for this emission.

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Transition: from level ............ to level .............

**(4)**



N 2 6 1 4 7 A 0 1 4 2 0

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(b) The spectrum of light from the Sun contains a dark line at a wavelength of 656 nm. With reference to the energy level diagram, explain how this line is produced. You may be awarded a mark for the clarity of your answer.

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**(4)**

(c) In the spectrum of light received from another galaxy, the same line appears at a wavelength of 695 nm.

(i) How can we deduce from this that the galaxy is receding from the Earth?

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**(1)**

(ii) Calculate the speed of recession of the galaxy.

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Speed = ............................................................
**(2)**

**Q8**

**(Total 11 marks)**

**TOTAL FOR PAPER: 60 MARKS**

**END**

## List of data, formulae and relationships

***Data***

| | | |
|---|---|---|
| Speed of light in vacuum | $c = 3.00 \times 10^8 \text{ m s}^{-1}$ | |
| Gravitational constant | $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ | |
| Acceleration of free fall | $g = 9.81 \text{ m s}^{-2}$ | (close to the Earth) |
| Gravitational field strength | $g = 9.81 \text{ N kg}^{-1}$ | (close to the Earth) |
| Elementary (proton) charge | $e = 1.60 \times 10^{-19} \text{ C}$ | |
| Electronic mass | $m_e = 9.11 \times 10^{-31} \text{ kg}$ | |
| Electronvolt | $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$ | |
| Unified atomic mass unit | $\text{u} = 1.66 \times 10^{-27} \text{ kg}$ | |
| Molar gas constant | $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ | |
| Permittivity of free space | $\varepsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ | |
| Coulomb Law constant | $k = 1/4\pi\varepsilon_0$ <br> $= 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$ | |
| Permeability of free space | $\mu_0 = 4\pi \times 10^{-7} \text{ N A}^{-2}$ | |
| Planck constant | $h = 6.63 \times 10^{-34} \text{ J s}$ | |

***Rectilinear motion***

For uniformly accelerated motion:

$$v = u + at$$

$$x = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

***Forces and moments***

Moment of $F$ about O = $F \times$ (Perpendicular distance from $F$ to O)

Sum of clockwise moments about any point in a plane = Sum of anticlockwise moments about that point

***Dynamics***

Force $\quad F = m\dfrac{\Delta v}{\Delta t} = \dfrac{\Delta p}{\Delta t}$

Impulse $\quad F\Delta t = \Delta p$

***Mechanical energy***

Power $\quad P = Fv$

***Radioactive decay and the nuclear atom***

Activity $\quad A = \lambda N \quad$ (Decay constant $\lambda$)

Half-life $\quad \lambda t_{\frac{1}{2}} = 0.69$

***Electrical current and potential difference***

Electric current $I = nAQv$

Electric power $P = I^2R$

***Electrical circuits***

Terminal potential difference $V = \mathcal{E} - Ir$ (E.m.f. $\mathcal{E}$; Internal resistance $r$)

Circuit e.m.f. $\Sigma\mathcal{E} = \Sigma IR$

Resistors in series $R = R_1 + R_2 + R_3$

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

***Heating matter***

Change of state: energy transfer $= l\Delta m$ (Specific latent heat or specific enthalpy change $l$)

Heating and cooling: energy transfer $= mc\Delta T$ (Specific heat capacity $c$; Temperature change $\Delta T$)

Celsius temperature $\theta/°\text{C} = T/\text{K} - 273$

***Kinetic theory of matter***

Temperature and energy $T \propto$ Average kinetic energy of molecules

Kinetic theory $p = \frac{1}{3}\rho\langle c^2\rangle$

***Conservation of energy***

Change of internal energy $\Delta U = \Delta Q + \Delta W$ (Energy transferred thermally $\Delta Q$; Work done on body $\Delta W$)

Efficiency of energy transfer $= \frac{\text{Useful output}}{\text{Input}}$

Heat engine: maximum efficiency $= \frac{T_1 - T_2}{T_1}$

***Circular motion and oscillations***

Angular speed $\omega = \frac{\Delta\theta}{\Delta t} = \frac{v}{r}$ (Radius of circular path $r$)

Centripetal acceleration $a = \frac{v^2}{r}$

Period $T = \frac{1}{f} = \frac{2\pi}{\omega}$ (Frequency $f$)

Simple harmonic motion:

displacement $x = x_0 \cos 2\pi ft$

maximum speed $= 2\pi fx_0$

acceleration $a = -(2\pi f)^2 x$

For a simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$

For a mass on a spring $T = 2\pi\sqrt{\frac{m}{k}}$ (Spring constant $k$)

***Waves***

| | | |
|---|---|---|
| Intensity | $I = \dfrac{P}{4\pi r^2}$ | (Distance from point source $r$; Power of source $P$) |

***Superposition of waves***

| | | |
|---|---|---|
| Two slit interference | $\lambda = \dfrac{xs}{D}$ | (Wavelength $\lambda$; Slit separation $s$; Fringe width $x$; Slits to screen distance $D$) |

***Quantum phenomena***

| | | |
|---|---|---|
| Photon model | $E = hf$ | (Planck constant $h$) |
| Maximum energy of photoelectrons | $= hf - \varphi$ | (Work function $\varphi$) |
| Energy levels | $hf = E_1 - E_2$ | |
| de Broglie wavelength | $\lambda = \dfrac{h}{p}$ | |

***Observing the Universe***

| | | |
|---|---|---|
| Doppler shift | $\dfrac{\Delta f}{f} = \dfrac{\Delta\lambda}{\lambda} \approx \dfrac{v}{c}$ | |
| Hubble law | $v = Hd$ | (Hubble constant $H$) |

***Gravitational fields***

| | | |
|---|---|---|
| Gravitational field strength | $g = F/m$ | |
| for radial field | $g = Gm/r^2$, numerically | (Gravitational constant $G$) |

***Electric fields***

| | | |
|---|---|---|
| Electrical field strength | $E = F/Q$ | |
| for radial field | $E = kQ/r^2$ | (Coulomb law constant $k$) |
| for uniform field | $E = V/d$ | |
| For an electron in a vacuum tube | $e\Delta V = \Delta(\frac{1}{2}m_e v^2)$ | |

***Capacitance***

| | | |
|---|---|---|
| Energy stored | $W = \frac{1}{2}CV^2$ | |
| Capacitors in parallel | $C = C_1 + C_2 + C_3$ | |
| Capacitors in series | $\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}$ | |
| Time constant for capacitor discharge | $= RC$ | |

***Magnetic fields***

| | | |
|---|---|---|
| Force on a wire | $F = BIl$ | |
| Magnetic flux density (Magnetic field strength) | | |
| in a long solenoid | $B = \mu_0 nI$ | (Permeability of free space $\mu_0$) |
| near a long wire | $B = \mu_0 I / 2\pi r$ | |
| Magnetic flux | $\Phi = BA$ | |
| E.m.f. induced in a coil | $\varepsilon = -\dfrac{N\Delta\Phi}{\Delta t}$ | (Number of turns $N$) |

***Accelerators***

| | |
|---|---|
| Mass-energy | $\Delta E = c^2 \Delta m$ |
| Force on a moving charge | $F = BQv$ |

***Analogies in physics***

| | |
|---|---|
| Capacitor discharge | $Q = Q_0 e^{-t/RC}$ |
| | $\dfrac{t_{\frac{1}{2}}}{RC} = \ln 2$ |
| Radioactive decay | $N = N_0 e^{-\lambda t}$ |
| | $\lambda t_{\frac{1}{2}} = \ln 2$ |

***Experimental physics***

$$\text{Percentage uncertainty} = \frac{\text{Estimated uncertainty} \times 100\%}{\text{Average value}}$$

***Mathematics***

$$\sin(90° - \theta) = \cos\theta$$

$$\ln(x^n) = n \ln x$$

$$\ln(e^{kx}) = kx$$

| | | |
|---|---|---|
| Equation of a straight line | $y = mx + c$ | |
| Surface area | cylinder $= 2\pi rh + 2\pi r^2$ | |
| | sphere $= 4\pi r^2$ | |
| Volume | cylinder $= \pi r^2 h$ | |
| | sphere $= \frac{4}{3}\pi r^3$ | |
| For small angles: | $\sin\theta \approx \tan\theta \approx \theta$ | (in radians) |
| | $\cos\theta \approx 1$ | |

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