**2017-18 MOCK**
**F.6 PHY**
PAPER 2

**TWGHs Wong Fut Nam College**
**Mock Examination 2017-18**

# F.6 PHYSICS PAPER 2

## Question-Answer Book

11:30 am – 12:30 pm (1 hour)
31 Jan 2018 (WED)

This paper must be answered in English

*Setter: Man Kin Pong*

| Student Name | | | | |
|---|---|---|---|---|
| Class No. | 6 | | | |

| Question No. | Marks |
|---|---|
| Section A<br>MC | |
| Section A<br>Structured question | |
| Section C<br>MC | |
| Section C<br>Structured question | |

**INSTRUCTIONS**

(1) After the announcement of the start of the examination, you should first write your name and class number in the space provided on the cover.

(2) This paper consists of **TWO** sections, Section A and C. Each section contains eight multiple-choice questions and one structured question which carries 10 marks. Attempt **ALL** questions in the **TWO** sections.

(3) Write your answers to the structured questions in this **QUESTION–ANSWER BOOK**. Do not write in the margins. Answer in the margins will not be marked. For multiple-choice questions, blacken the appropriate circle with an HB pencil. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.

(4) Graph paper and supplementary answer sheets will be provided on request. Write your name and class number and mark the question number box on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.

(5) The diagrams in this section are **NOT** necessarily drawn to scale.

(6) The last two pages of this Question-Answer Book contain a list of data, formulae and relationships which you may find useful.

(7) No extra time will be given to candidates for filling in the question number boxes after the 'Time is up' announcement.

**Section A: Astronomy and Space Science**

**Q.1: Multiple–choice questions**

1.1 Which of the following is/ are correctly arranged in descending order of size?

(1) Cluster of galaxies, Milky Way, star cluster, planet

(2) Galaxy, star, Mars, man-made satillte

(3) Nebula, star cluster, star, planetary system

A. (1) only

B. (1) and (2) only

C. (2) and (3) only

D. (1), (2) and (3)

**A** ○ **B** ○ **C** ○ **D** ○

1.2 Which of the following is suggested by the heliocentric model proposed by Copernicus but not consistent with the universe we know nowadays?

(1) The Moon moves around the Earth.

(2) Planets move around the sun in circular orbits.

(3) The orbit of Mercury around the Sun is inside the Earth's orbit around the Sun.

A. (2) only

B. (3) only

C. (1) and (2) only

D. (2) and (3) only

**A** ○ **B** ○ **C** ○ **D** ○

1.3 An object is at a certain distance from the surface of the Earth. It has a mass of 10 kg and possesses a gravitational potential energy of $-6.3 \times 10^8$ J. It then starts to move away from the Earth with initial speed $v$. What is the minimum value of $v$ so that the object will never return?

A. 7940 m $s^{-1}$

B. 11 200 m $s^{-1}$

C. 56 100 m $s^{-1}$

D. 79 400 m $s^{-1}$

**A** ○ **B** ○ **C** ○ **D** ○

1.4 Which of the following statements about red giants are correct?

(1) Most red giants have high luminosity.

(2) Most red giants have high surface temperature.

(3) Most red giants have large radius.

A. (1) and (2) only

B. (1) and (3) only

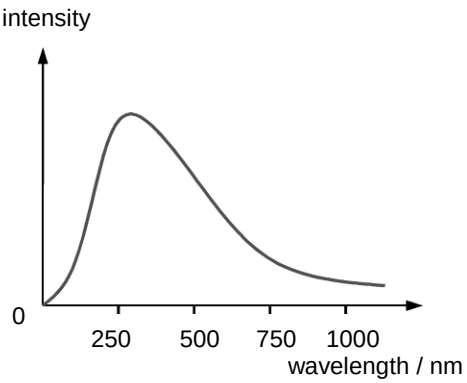
C. (2) and (3) only

D. (1), (2) and (3)

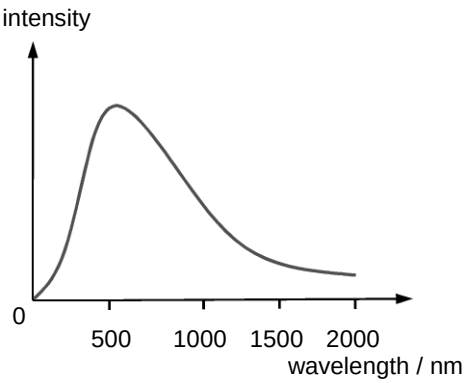
**A** ○ **B** ○ **C** ○ **D** ○

1.5 Scientists investigate the electromagnetic radiation emitted from the Earth by treating the Earth as a black body with a surface temperature of about 290 K. Which of the following curves best shows the radiation curve of the Earth?

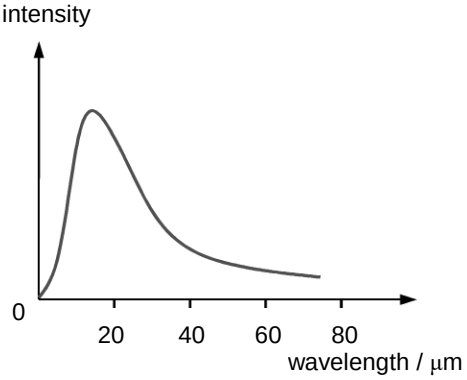
A.



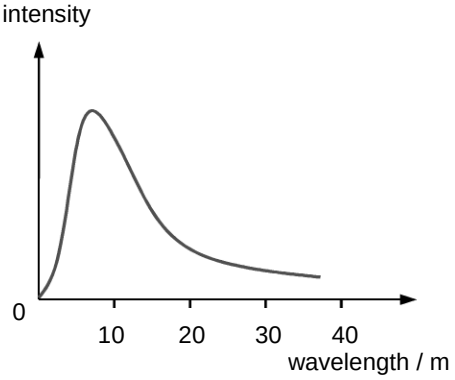

B.




C.




D.




| A | B | C | D |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

1.6 The wavelength of a hydrogen spectral line from a distant galaxy is measured to be 654.3 nm while the same spectral line from our Sun found to be 656.3 nm. Find the radial velocity of the galaxy with respect to Earth.

A. 914 km $s^{-1}$ away from Earth
B. 914 km $s^{-1}$ toward from Earth
C. 917 km $s^{-1}$ away from Earth
D. 917 km $s^{-1}$ toward from Earth

| A | B | C | D |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

1.7 Star *Y* has a luminosity 0.001 times that of the Sun while its surface temperature is the same as the Sun's. Its spectrum has a line with a wavelength of 393.5 nm. The wavelength of the same spectral line observed in the laboratory is 393.4 nm. Which of the following about star *Y* is **incorrect**?

A. The spectral line of star *Y* is red-shifted.
B. Star *Y* is a white dwarf.
C. The size of star *Y* relative to the Sun can be determined from the information provided.
D. The distance of star *Y* from the Earth can be determined from the information provided.

**A** ○ **B** ○ **C** ○ **D** ○

1.8 Which of the folloing statements correctly describe(s) the motion of stars in the Milky Way?

(1) The rotational speed of a stellar body is highest when situtated very close to the galactic centre.
(2) The rotational speed of a stellar body far from the galactic centre appears smaller than expected.
(3) The total mass of dark matter is greater than that of ordinary matter.

A. (2) only
B. (3) only
C. (1) and (2) only
D. (1) and (3) only

**A** ○ **B** ○ **C** ○ **D** ○

**Q.1: Structured question**

(a) A comet is a small celestial body orbiting the Sun. When it comes close to the Sun, it is heated up and its evaporated dust and gas form long tails (Figure 1.1). Halley is one of the best known comets. It orbits the Sun with a period of 75.3 years. Take the mass of the Sun to be $1.99 \times 10^{30}$ kg.

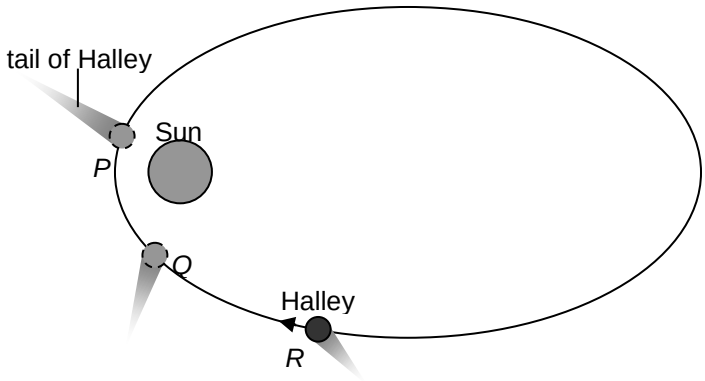



**Figure 1.1**

(i) Suppose Halley is 1.3 AU from the Earth at point *P*. An observer on the Earth can see a visible tail of Halley that is 9° long and perpendicular to the line of sight. Estimate the length of the tail in kilometres.

(2 marks)

(ii) Compare the speeds of Halley when it is at points *Q* and *R*. Explain your answer.

(3 marks)

(b) Figures 1.2a and 1.2b show two photos of a star *X* (the biggest bright dot) taken at the same location taken six months apart in the same year. In this period, star *X* shows a maximum shift in position relative to background stars over one year. The kite-like shape in the photos outlines the constellation. In the two photos, star *X* appears at slightly different locations in the sky.

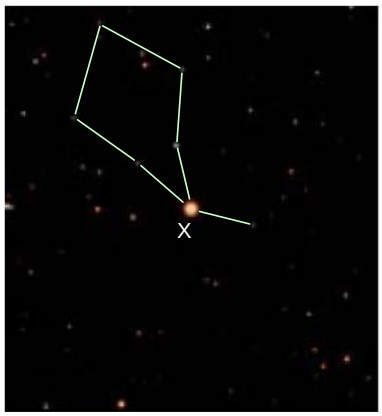



**Figure 1.2a**

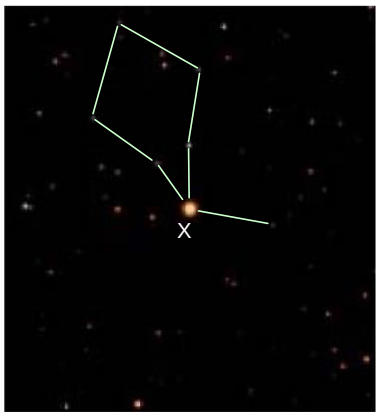



**Figure 1.2b**

(i) The parallax of star *X* measured from the photos above is 0.089″. Estimate the distance of star *X* from the Earth in light years.

(2 marks)

(ii) The method of parallax is possible if we adopt the Copernican heliocentric model instead of the Ptolemaic geocentric model. Explain.

(1 mark)

(iii) The radius and the surface temperature of star X are $1.79 \times 10^{10}$ m and 4290 K respectively. Estimate the luminosity of star X in terms of $L_\odot$, where $L_\odot$ is the luminosity of the Sun ($3.84 \times 10^{26}$ W).

(2 marks)

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**Section C: Energy and Use of Energy**

**Q.3: Multiple–choice questions**

3.1 Lamp *X* has a higher input power than lamp *Y*. Which of the following statements must be correct?

(1) Lamp *X* is brighter than lamp *Y*.

(2) The cost of electricity of using lamp *X* is higher than that of lamp *Y*.

(3) Lamp *Y* is more energy efficient than lamp *X*.

A. (1) only

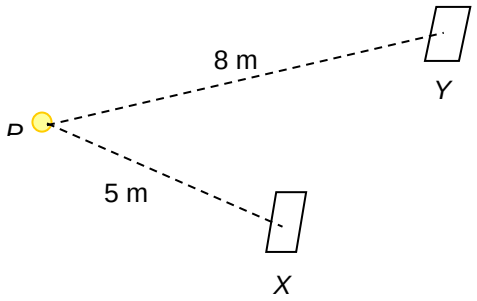
B. (2) only

C. (1) and (2) only

D. (1), (2) and (3)

| **A** | **B** | **C** | **D** |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

3.2 Surface *X* is 5 m away from a point source of light *P* and surface *Y* is 8 m away from *P* as shown. The areas of *X* and *Y* are very small and the light from *P* hits the surfaces perpendicularly. If the illuminance at *X* due to *P* is 50 lx, what is the illuminance at *Y* due to *P*?




A. 6.25 lx

B. 19.5 lx

C. 31.3 lx

D. 128 lx

| **A** | **B** | **C** | **D** |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

3.3 Which of the following is/are (an) advantage(s) of an electric hotplate over an induction cooker?

(1) An electric hotplate heats food without generating heat itself.

(2) An electric hotplate is more energy efficient.

(3) An electric hotplate can be used with non-metallic pots.

A. (2) only

B. (3) only

C. (1) and (3) only

D. (1), (2) and (3)

| **A** | **B** | **C** | **D** |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

3.4 The table below shows the input powers and the cooling capacities of air-conditioners *X* and *Y*.

| | **Input power / W** | **Cooling capacity / W** |
|---|---|---|
| *X* | 800 | 1600 |
| *Y* | 1200 | 2400 |

Which of the following statements about *X* and *Y* is/are correct?

(1) *Y* cools a room faster than *X* does.

(2) *Y* consumes more energy than *X* does in cooling a room.

(3) *Y* removes more heat from the room to the outside than *X* does within the same period of time.

A. (1) only

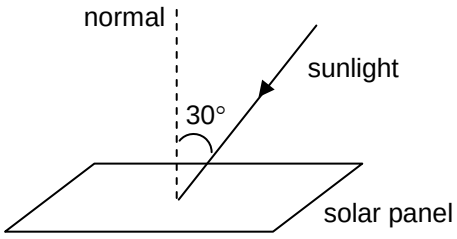
B. (2) only

C. (1) and (3) only

D. (1), (2) and (3)

**A** ○ **B** ○ **C** ○ **D** ○

3.5 An artificial satellite orbits around the earth near the outer surface of the earth's atmosphere. On the satellite, there is a solar panel of area 20 $m^2$. The efficiency of the solar panel is 15%. What is the power output of the solar panel when its normal makes an angle of 30° to the incident sunlight? Take the solar constant to be 1366 W $m^{-2}$.




A. 2050 W

B. 3550 W

C. 4100 W

D. 27 300 W

**A** ○ **B** ○ **C** ○ **D** ○

3.6 Which of the following statements about an electric vehicle is/are correct?

(1) It does not give out air pollutants.
(2) Its end-use energy efficiency is higher than that of a fossil-fuel vehicle.
(3) It has a smaller combustion engine than a fossil-fuel vehicle of a similar size.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

**A** ○ **B** ○ **C** ○ **D** ○

3.7 Which of the following measures can help a building attain high energy efficiency?

(1) Construct the building envelope with high OTTV.

(2) Install solar control window films.

(4) Reuse the heat generated by central air-conditioning system.

A. (1) and (2) only

B. (1) and (3) only

C. (2) and (3) only

D. (1), (2) and (3)

| **A** | **B** | **C** | **D** |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

3.8 A $^{235}_{92}U$ nucleus is hit by a neutron and splits into two nuclei $^{89}_{36}Kr$ and $^{144}_{56}Ba$, releasing some neutrons. Suppose the mass of a neutron is 1 u. If the mass of the mother nucleus is 235.04 u and that of the daughter nuclei are 88.91 u and 143.92 u respectively, which of the following is/are correct?

(1) 2020 MeV of energy is released in this reaction.

(2) This is called a chain reaction.

(3) It is easier to start such a reaction if the neutron hitting the mother nucleus is slower.

A. (2) only

B. (3) only

C. (1) and (3) only

D. (1), (2) and (3)

| **A** | **B** | **C** | **D** |
|---|---|---|---|
| ○ | ○ | ○ | ○ |

**Q.3: Structured question**

The following shows a small hydroelectric power generation system.

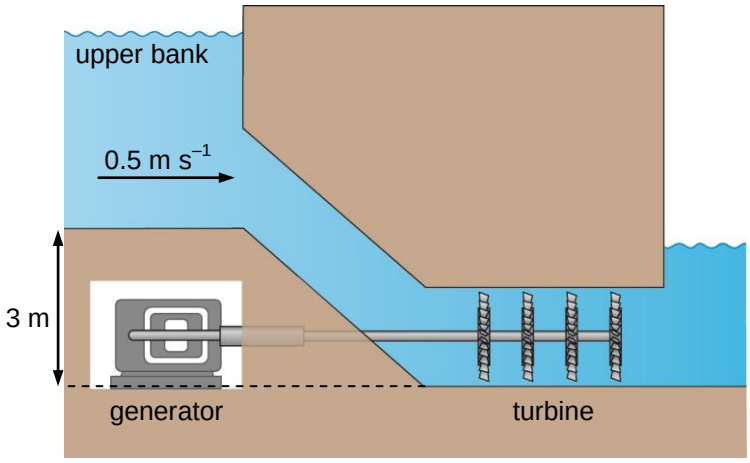



**Figure 3.1**

(a) The water at the upper bank flows at 0.5 m s$^{-1}$. Assume that all gravitational potential energy lost by the water turns into kinetic energy when it flows from the upper bank to the turbine, which is 3 m below the upper bank. Find the speed of the water stream when it reaches the turbine.

(2 marks)

(b) The turbine is circular in shape and its diameter is 2 m. If the output power of the generator is 500 kW, find its efficiency. The density of water is 1000 kg m$^{-3}$.

(2 marks)



Go on to the next page

(c) Give **TWO** reasons why not all the kinetic energy of the water turns into electrical energy in the generator.

(2 marks)

(d) State **ONE** advantage and **ONE** disadvantage of hydroelectric power.

(2 marks)

(e) Hydroelectric power is not applicable to Hong Kong. Suggest **TWO** possible renewable energy sources for Hong Kong.

(2 marks)

**END OF PAPER**

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## List of data, formulae and relationships

**Data**

| | |
|---|---|
| molar gas constant | $R = 8.31\ J\ mol^{-1}\ K^{-1}$ |
| Avogadro constant | $N_A = 6.02\times10^{23}\ mol^{-1}$ |
| acceleration due to gravity | $g = 9.81\ m\ s^{-2}$ (close to the Earth) |
| universal gravitational constant | $G = 6.67\times10^{-11}\ N\ m^2\ kg^{-2}$ |
| speed of light in vacuum | $c = 3.00\times10^{8}\ m\ s^{-1}$ |
| charge of electron | $e = 1.60\times10^{-19}\ C$ |
| electron rest mass | $m_e = 9.11\times10^{-31}\ kg$ |
| permittivity of free space | $\varepsilon_o = 8.85\times10^{-12}\ C^2\ N^{-1}\ m^{-2}$ |
| permeability of free space | $\mu_o = 4\pi\times10^{-7}\ H\ m^{-1}$ |
| atomic mass unit | $u = 1.661\times10^{-27}\ kg$ (1 u is equivalent to 931 MeV) |
| astronomical unit | $AU = 1.50\times10^{11}\ m$ |
| light year | $ly = 9.46\times10^{15}\ m$ |
| parsec | $pc = 3.09\times10^{16}\ m = 3.26\ ly = 206265\ AU$ |
| Stefan constant | $\sigma = 5.67\times10^{-8}\ W\ m^{-2}\ K^{-4}$ |
| Planck constant | $h = 6.63\times10^{-34}\ J\ s$ |

**Rectilinear motion**

For uniformly accelerated motion:

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 - u^2 = 2as$$

**Mathematics**

| | |
|---|---|
| Equation of straight line | $y = mx + c$ |
| Arc length | $= r\theta$ |
| Surface area of cylinder | $= 2\pi rh + 2\pi r^2$ |
| Volume of cylinder | $= \pi r^2 h$ |
| Surface area of sphere | $= 4\pi r^2$ |
| Volume of sphere | $= \frac{4}{3}\pi r^3$ |

For small angles, $\sin\theta \approx \tan\theta \approx \theta$ (in radians)

**Astronomy and Space Science**

| | |
|---|---|
| $U = -\frac{GMm}{r}$ | gravitational potential energy |
| $p = \sigma AT^4$ | Stefan's law |
| $\left\|\frac{\Delta f}{f_o}\right\| \approx \frac{v}{c} \approx \left\|\frac{\Delta\lambda}{\lambda_o}\right\|$ | Doppler effect |

**Energy and Use of Energy**

| | |
|---|---|
| $E = \frac{\Phi}{A}$ | illuminance |
| $\frac{Q}{t} = k\frac{A(T_H - T_C)}{d}$ | rate of energy transfer by conduction |
| $U = \frac{k}{d}$ | thermal transmittance U-value |
| $P = \frac{1}{2}\rho Av^3$ | maximum power by wind turbine |

**Atomic World**

| | |
|---|---|
| $\frac{1}{2}m_e v_{\max}^2 = hf - \Phi$ | Einstein's photoelectric equation |
| $E_n = \frac{1}{n^2}\left\{\frac{m_e e^4}{8h^2\varepsilon_o^2}\right\} = -\frac{13.6}{n^2}eV$ | energy level equation for hydrogen atom |
| $\lambda = \frac{h}{p} = \frac{h}{mv}$ | de Broglie formula |
| $\theta = \frac{1.22\lambda}{d}$ | Rayleigh criterion (resolving power) |

**Medical Physics**

| | |
|---|---|
| $\theta = \frac{1.22\lambda}{d}$ | Rayleigh criterion (resolving power) |
| $power = \frac{1}{f}$ | power of lens |
| $L = 10\log\frac{I}{I_o}$ | intensity level (dB) |
| $Z = \rho c$ | acoustic impedance |
| $\alpha = \frac{I_r}{I_o} = \frac{(Z_2 - Z_1)^2}{(Z_2 + Z_1)^2}$ | intensity reflection coefficient |
| $I = I_o e^{-\mu x}$ | transmitted intensity through a medium |

| | | |
|---|---|---|
| A1. | $E = mc\Delta T$ | energy transfer during heating and cooling |
| A2. | $E = l\Delta m$ | energy transfer during change of state |
| A3. | $pV = nRT$ | equation of state for ideal gas |
| A4. | $pV = \frac{1}{3}Nm\overline{c^2}$ | kinetic theory equation |
| A5. | $E_k = \frac{3RT}{2N_A}$ | molecular kinetic energy |
| B1. | $F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$ | Force |
| B2. | $moment = F \times d$ | moment of a force |
| B3. | $E_p = mgh$ | gravitational potential energy |
| B4. | $E_k = \frac{1}{2}mv^2$ | kinetic energy |
| B5. | $P = Fv$ | mechanical power |
| B6. | $a = \frac{v^2}{r} = \omega^2 r$ | centripetal acceleration |
| B7. | $F = \frac{Gm_1m_2}{r^2}$ | Newton's law of gravitation |
| C1. | $\Delta y = \frac{\lambda D}{a}$ | fringe width in double-slit interference |
| C2. | $d\sin\theta = n\lambda$ | diffraction grating equation |
| C3. | $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ | equation for a single lens |
| D1. | $F = \frac{Q_1Q_2}{4\pi\varepsilon_o r^2}$ | Coulomb's law |
| D2. | $E = \frac{Q}{4\pi\varepsilon_o r^2}$ | electric field strength due to a point charge |
| D3. | $E = \frac{V}{d}$ | electric field between parallel plates (numerically) |
| D4. | $R = \frac{\rho l}{A}$ | resistance and resistivity |
| D5. | $R = R_1 + R_2$ | resistor in series |
| D6. | $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ | resistor in parallel |
| D7. | $P = IV = I^2R$ | power in a circuit |
| D8. | $F = BQv\sin\theta$ | force on a moving charge in a magnetic field |
| D9. | $F = BIl\sin\theta$ | force on a current-carrying conductor in a magnetic field |
| D10. | $B = \frac{\mu_o I}{2\pi r}$ | magnetic field due to a long straight wire |
| D11. | $B = \frac{\mu_o NI}{l}$ | magnetic field inside a long solenoid |
| D12. | $\varepsilon = N\frac{\Delta\Phi}{\Delta t}$ | induced e.m.f. |
| D13. | $\frac{V_s}{V_p} \approx \frac{N_s}{N_p}$ | ratio of secondary voltage to primary voltage in a transformer |
| E1. | $N = N_o e^{-kt}$ | law of radioactive decay |
| E2. | $t_{\frac{1}{2}} = \frac{\ln 2}{k}$ | half-life and decay constant |
| E3. | $A = kN$ | activity and the number of undecayed nuclei |
| E4. | $\Delta E = \Delta mc^2$ | mass-energy relationship |