MARKING SCHEME & SOLUTIONS

PRE-LEAVING CERTIFICATE PHYSICS, 2005

Ordinary & Higher Levels

TABLE OF CONTENTS

GENERAL GUIDELINES

In considering this marking scheme the following points should be noted:

1. In many instances only key words are given, words that must appear in the **correct context** in the candidate's answer in order to merit the assigned marks.

2. Words, expressions or statements separated by a solidus, /, are alternatives which are equally acceptable.

3. The descriptions, methods and definitions in the scheme are not exhaustive and alternative valid answers are acceptable.

4. The detail required in any answer is determined by the context and manner in which the question is asked and by the number of marks assigned to the answer in the examination paper.

5. For lack of units, or incorrect units, one mark is deducted, when indicated.

6. Each time an arithmetical slip occurs in a calculation one mark is deducted.

ORDINARY LEVEL — SOLUTIONS

This marking scheme is not exhaustive. Alternative valid answers are acceptable.

SECTION A

1. Boyle's law apparatus, pump or large syringe connected to pressure gauge. (**5)**

Pressure changed by pump regulator. **(5)**
Wait for oil to drain from sides or wait for equilibrium. **(5)**

$\frac{1}{V}$	0.024	0.029	0.033	0.038	0.043	0.048	0.056

Graph:

- At least three-quarter page size. **(3)**
- Axes labelled. **(3)**
- At least 5 points plotted correctly. **(3)**
- Straight line of good fit. **(3)**

Straight line implies $P \propto \frac{1}{V}$

or PV=constant **(6)**

2. Open-ended tube in cylinder with water. **(5)**

Length changed by raising/lowering tube in water. (**5)**

$l_e = l_a + 0.3d$

$= 34 + 0.3(0.5)$ **(10)**

$= 34.15cm$

$\lambda = 4l_e$ **(10)**

$v = f\lambda$

$= 256(136.6) = 349.7ms^{-1}$ **(10)**

3. $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ **(10)**

f	15.0	15.1	14.7	14.9

$f_{av} = 14.9cm$ **(8)**

focal length is 15cm approx. If object is placed at u=10 then inside focal length and image is virtual – cannot be placed on screen. **(10)**

4. Thermistor is immersed in non-conducting oil and heated in water bath. **(10)**
Multimeter or Wheatstone bridge. **(10)**
Graph:

- At least three-quarter page size. **(3)**
- Labelled axes. **(3)**
- 5 accurate points. **(3)**
- Smooth curve. **(3)**

Estimate of resistance at 50 approx. 480-490 Ω. **(8)**

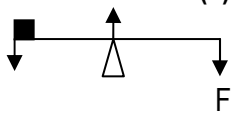
5. **(a)** kg **(7)**
(b) 98J **(7)**
(c) Roof is better insulator since lower U-value. **(7)**
(d) $6.04x10^{-7}m$ or 604nm **(7)**
(e) Coulomb C **(7)**
(f) P.D. work done moving unit charge from one point to another. **(7)**
(g) $F = BIl$ **(7)**

$\Rightarrow 0.8 = B(4)(0.4)$

$\Rightarrow B = 0.5T$

(h) **E**mission of electrons from hot body. **(7)**
(i) Ionising effect or penetration or e-m wave. **(7)**
(j) Number of disintegrations per second. **(7)**

6. **(i)** **M**oment about axis= product of force and perpendicular distance between axis and line of action of force. **(8)**
(ii) Couple= system of forces which has turning effect only, resultant of forces is zero. **(8)**
(iii) Conditions for equilibrium: algebraic sum of forces on body is zero or no resultant force on body. **(4)**
(iv) algebraic sum of moments zero or clockwise moments= anti-clockwise moments. **(4)**



6 Marks

Force at end of board:

$W = mg = 53x9.8 = 519.4N$ **(10)**

$B + W = F$ **(8)**

$T = 519.4x3.6 = 1869.8Nm$ **(8)**

7. **(i)** shc=amount of heat energy to raise 1kg of substance by 1K. **(8)**

(ii) slhc=amount of heat energy to change state of 1kg of substance. **(8)**

Experiment:

Apparatus:

Insulated calorimeter, joulemeter, thermometer. **(4)**

Measurements:

Energy from joulemeter, temperature, mass of water. **(4)**

Use of $\Delta Q = mc\Delta T$ to calculate c. **(4)**

$$\Delta Q = mc\Delta T$$

$$8x10^5 = 65c(3.2) \Rightarrow c = 3846J$$

(14)

Radiation and conduction. **(3 + 3)**

$$3.4x10^5 = m(2.4x10^6)$$

$$\Rightarrow m = 0.14kg$$

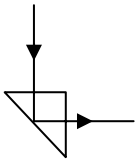
(8)

8. **(i)** Incident ray, normal, refractive ray in the same plane. **(6)**

(ii) $\frac{\sin i}{\sin r} = \text{constant} = n$ **(6)**

C.A.=angle of incidence in denser medium for which angle of refraction in less dense medium is 90 degrees. **(8)**

$$\sin C = \frac{1}{n} \Rightarrow C = 42^0$$ **(8)**



(11)

T.I.R when angle of incidence at surface between more dense and less dense medium greater than critical angle so that all light reflected back into denser medium. **(8)**

Telecommunications: optical fibres – light carrying information travels with t.i.r along glass tube. **(11)**

Medicine: endoscope uses light travelling along optical glass fibres with t.i.r. to view inside of stomach, lungs etc without surgery. **(9)**

9. Capacitance= ratio of charge to voltage in a capacitor. **(8)**

Unit is Farad (F). **(6)**

$$C = \frac{Q}{V} = \frac{7.2x10^{-5}}{12} = 6x10^{-6}F$$

or $6\mu F$ **(10)**

Bulb light bulb lights briefly and then fades out. **(12)**

Capacitor gives large charge for short time. **(10)**

Capacitors in:

- radio circuits
- defibrillators
- neon lights. **(10)**

10. α-radiation: helium nucleus, 2 protons, 2 neutrons, -positively charged. **(4)**

β-radiation:electron from nucleus – negatively charged. **(4)**

γ-radiation: e-m radiation of high energy. **(4)**

Ionising: shown in G-M tube – radiation ionises gas in tube –electrons move to anode – current detected. **(10)**

Z=82 **(6)**

A=210 **(6)**

$T_{\frac{1}{2}}$ = time taken for half of sample to decay. **(10)**

Uses: 2 of:

- Medical diagnostics – use of radioactive tracers.

- Medical theraputics- irradiation of cancer cells.
- Industrial use for thickness control.
- Food irradiation.
- Smoke detectors, etc. **(6 + 6)**

11. **(a)** Magnetic field – region of space around a moving charge or region of Space in which a moving charge experiences a force. **(8)**

(b) Fusion= joining of 2 small nuclei to form one large nucleus with release of energy. **(8)**

(c) Kelvin. **(8)**

(d) Temp. beyond melting and boiling point of any material on earth. **(8)**

(e) Magnetic flux density, size of current, velocity of charge. (any 2) **(8)**

(f) Vector. **(8)**

(g) Raw materials readily available, clean source of large energy. **(8)**

12.

(a) PCM: in closed system in any interaction, total p before interaction = total p after interaction. **(8)**

Experiment:

Apparatus:

2 trolleys, ramp ticker timer. **(3)**

Method:

Release one trolley- collision- stick together and move together. **(3)**

Measurements:

vel. before, vel of both after, masses. **(3)**

Calculation:

$mu = (m + M)v$ **(3)**

$8(2) + 12(1) = 20v \Rightarrow v = 1.4ms^{-1}$ **(8)**

(b) S. I. level = log of ratio of sound intensity to threshold frequency. **(6)**

Threshold= lowest intensity to which ear will respond. **(6)**

Bels or dB. **(5)**

Adaption to ear's response. **(7)**

Insulate vibrating parts from each other. **(4)**

(c) Faraday's law: rate of change of flux prop. to emf induced. **(4)**

Lenz's law: direction of induced current opposes motion/change causing it. **(4)**

Experiment: Moving magnet w.r.t coil.

Apparatus: Magnet, coil, galvanometer. **(2)**

Method: Move magnet towards coil. **(2)**

Observation: Current registered in galvanometer. **(2)**

Change in flux of earth's magnetic field through window induces current in metal frame. **(5)**

Stationary: current stops – no flux. **(5)**

Magnetic to electrical. **(4)**

(d) Photoeffect: emission of electrons from surface of metal by e-m radiation of suitable frequency. **(8)**

$E = hf = 3.63x10^{-19} J$ **(4)**

Photocell: cathode plate, anode pin, evacuated tube. **(3 x 2)**

Energy of e-m radiation transferred to electrons – binding energy broken and electrons get kinetic energy. **(5)**

Applications:

- Motion detectors on alarms.
- Sound track on film.
- Pilot light monitoring on heating systems.
- Street light switches, etc. **(5)**

HIGHER LEVEL LEVEL — SOLUTIONS

This marking scheme is not exhaustive. Alternative valid answers are acceptable.

SECTION A

1. Table for T^2:

Length/m	**0.35**	**0.45**	**0.55**	**0.65**	**0.75**	**0.85**	**0.95**
T^2 / s^2	**1.39**	**1.78**	**2.13**	**2.54**	**2.90**	**3.40**	**3.82**

(4)

Graph:

- Axes labelled. **(2)**
- 5 points correct. **(2)**
- Straight line good fit. **(2)**
- use of slope in $m = \frac{4\pi^2}{g}$. **(4)**
- Value of g=9.8ms-2 approx. **(2)**

Amplitude decreases – loss in energy due to dissipative friction. **(12)**

Accuracy:
Mention 2 things – larger number of oscillations suggests better accuracy for T BUT energy in system dissipated due to friction therefore too many decreases accuracy. **(7)**
Measuring to centre of bob, etc. **(5)**
Fixing between 2 corks or other. **(4)** **(40)**

2. Graphs: **(2x6)**

- Labelled axes. **(2)**
- Fixed points graphed correctly. **(2)**
- Straight line. **(2)**

(a) At 22.6mm temp is 18 degrees (from graph.) **(10)**
(b) Temperature according to thermistor graph is 19 degrees. **(9)**
(c) different thermometric properties being used in each thermometer so they do not agree or different properties such as length and resistance do not necessarily change with temperature in precisely the same way or temp scale always depends somewhat on the specific properties of the material used in the thermometer. **(9)**

3. **(i)** Plot $\frac{1}{u}$ against $\frac{1}{v}$ is suitable. **(4)**
(ii) Labelled axes. **(3)**
(iii) 5 points graphed accurately. **(3)**
(vi) Straight line of good fit. **(3)**
(v) Focal length using $\frac{1}{f}$ =y-intercept. **(3)**
(vi) 2 estimates using formula: values around 10cm. (**2 x 6)**

Result from graph should be more accurate depending on goodness of fit as more data is used. Individual estimates less accurate. **(6)**

Image will not be formed if u is less than 10cm. **(6)**

4. **(i)** Suitable graph V(y) and I(x) or v.v. **(3)**
(ii) Labelled axes. **(3)**
(iii) 5 points plotted correctly. **(3)**
(vi) Straight line of good fit. **(3)**

Device is most likely a filament bulb increase in current is slowed down because of increase in resistance as temperature increases. **(8)**

P.D. 120V gives current of approx 0.18A. **(6)**

Current of 0.13A gives P.D. of approx 65V. **(6)**

Filament bulb does **not** obey Ohm's law. **(4)**

Graph is not a straight line as expected from Ohm. **(4)**

SECTION B

5.

(a) Average speed = 3.3ms^{-1} **(4)**
Average velocity = 0 **(3)**

(b) Body partially or wholly immersed in liquid, upthrust equal to the weight of liquid displaced **(7)**

(c) Power **(7)**

(d) shc = heat energy needed to raise 1kg of substance by 1K **(7)**

(e) 0.58m **(7)**

(f) 3 x 10^{-4}C **(7)**

(g) constant current if maintained in two thin straight parallel conductors of infinite length placed 1m apart in vacuum causes mutual force of 2x10^{-7}N per metre length. **(7)**

(h) $3.62x10^{14}\,Hz$ **(7)**

(i) When beam of high speed electrons (high energy) allowed to strike a metal target. **(7)**

(j) Rate of decay of isotope proportional to the number of nuclei present at any time- number of disintegrations per second proportional to the number of nuclei present. **(7)**

6. PCM: in closed system in any interaction, total p before interaction = total p after interaction **(12)**

Experiment:
Apparatus: 2 trolleys, ramp ticker timer **(3)**
Method: release one trolley- collision- stick together and move together. **(3)**

Measurements: vel. before, vel of both after, masses. **(3)**

Calculation: $mu = (m + M)v$ **(3)**
Mention cause of error **(2)**

They do not have the same momentum. Momentum is a vector quantity. The directions of the two cars are different therefore different momentums. **(8)**

(i) Change in momentum = 9.36 x 10^{-23}Ns **(8)**
(ii) Number of molecules = 1.1 x 10^{23} **(8)**
(iii) Pressure = 100kPa. **(6)**

7. Resonance= transfer of energy between 2 bodies with same natural frequency **(6)**

Sound intensity=rate at which energy is crossing unit area perp. to direction of sound **(6)**
(i) length of string =0.325m or 32.5cm **(8)**
(ii) tension is 63.8N or 64N **(8)**
Sound level = 9.3 Bels or 93dB **(10)**
Increase =96-93=3dB **(9)**
Sound intensity = 1Wm^{-2} **(9)**

8. **Faraday's law:** rate of change of flux prop. to emf induced. **(6)**

Lenz's law: direction of induced current opposes motion/change causing it. **(6)**

Experiment: moving magnet w.r.t coil

Apparatus: magnet, coil, galvanometer **(2)**
Method: move magnet towards coil **(2)**
Observation: current registered in galvanometer **(3)**

$F = Bqv$ **(8)**
Charges move a to b **(8)**
Induced current flows around loop in anti-clockwise direction **(8)**

$W = F.s = (Bqv)l$ **(4)**

$\varepsilon = V = \frac{W}{q} = Bvl$ **(4)**

$V = Bvl$
v = 4.2ms^{-1} **(5)**

9. Minimum frequency of incident radiation necessary to cause the photoelectric effect **(10)**

Kinetic energy of electrons depend on energy of photons but the energy of photon is proportional to frequency $E = hf$.
Energy of electrons depends on frequency and not on intensity (Intensity changes the *number* of electrons emitted) **(12)**

$E = hf = \Phi + \frac{1}{2}mv^2$ **(12)**

(i) break binding of electrons **(6)**

(ii) k.e. of electrons **(6)**

Work function=4.14x10^{-19}J **(11)**

10. **(a)** (i) pair production= creation of electron and positron from pure energy. **(6)**
eqn: $\gamma \rightarrow e^- + e^+$ **(6)**

(ii) pair annihilation =interaction of matter and anti-matter resulting in high energy radiation. **(6)**
eqn: $e^- + e^+ \rightarrow \gamma\,(2hf)$ **(6)**

Momentum is conserved by electron and positron moving in opposite directions to keep momentum = 0 **(8)**

According to Einstein, energy equivalence of a mass particle is $E = mc^2$, since 2 particles are annihilated then $E = 2mc^2$ and positron has same mass as electron. **(6)**

Min energy required = 1.02 Mev or 1.64x10^{-13}J. **(6)**
photons considered particles and therefore have momentum.

Conservation of momentum demands that total momentum nearly zero, only two photons moving in opposite directions can ensure this. **(12)**

(b) 2 junction diodes joined back to back. Middle layer is base, very thin and only slightly doped. Outer layers are thicker and called emitter and collector. **(9)**

Diagram. **(5)**

Circuit: elements include

- variable resistance in base circuit **(3)**
- Protective resistance in series with base. **(3)**
- Transistor symbol correct. **(3)**
- Constant voltage in collector circuit. **(3)**
- Milli- and micro-ammeters. **(4)**

- Collector current increases proportionally to base current for constant voltage in collector current. **(10)**
- Key is placing of *load resistor* (approx 1 $k\Omega$) in the collector circuit. **(10)**
- Voltage inverter, switch, etc. **(6)**

11. **(a)** Isotope: atoms with same atomic number but different mass numbers. **(8)**

(b) $^{60}_{27}Co \rightarrow ^{60}_{28}Ni + ^{0}_{-1}\beta$ **(8)**

(c) Beta is matter, gamma is wave, etc. (**8)**

(d) Time take for half sample to decay. **(8)**

(e) $4x10^{-9}s^{-1}$ **(8)**

(f) 2 protons, 2 neutrons. **(8)**

(g) Gamma (no alpha emitted and beta is absorbed by metal sheets). **(8)**

12. **(a)** Force to keep body in motion in circle. **(6)**

Directed towards the centre of circle of motion. **(6)**

Speed is scalar quantity, body can have constant speed but can have acceleration if direction is changing. **(8)**

(i) $22.5ms^{-1}$ **(2)**
(ii) 0 **(2)**
(iii) $56.3ms^{-1}$ **(4)**

(b) Doppler Effect: apparent change infrequency of a wave due to the motion of the source of the wave (or the observer). **(10)**

Diagram: **(6)**

(i) frequency on approach =1008Hz **(4)**
(ii) frequency moving away = 907Hz **(4)**

Device: speed gun, weather radar, etc **(4)**

(c) **(i)** Resistance=ratio of voltage to current in a conductor. **(3)**
(ii) The resistance of a conductor of length 1m and cross-sectional area $1m^2$. **(3)**

Length, cross-sectional area, etc **(2 x 3))))**

2 resistors in series, 1m length of wire in parallel with these, galvanometer connected between resistors with movable contact to wire. **(6)**

Reason is accuracy in measurement of length. If a length is very small there is larger error in measurement. **(6)**

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}$$
$$\Rightarrow \frac{10}{x} = \frac{35}{65}$$
$$x = 18.6\Omega$$

(4)

(d) Rutherford: bombarded gold foil with α-particles: most passed straight through, some deflected through an angle, very few rebounded on path. **(6)**

Conclusion: atom mainly empty space, +charge at centre of atom very small. **(4)**

Bohr: electrons in atom can only have fixed energies/energy levels. **(6)**

Line spectrum: when electrons change from higher to lower energy levels photons of energy is emitted equal to difference in energy levels. This energy appears as line in spectrum. **(4)**

$$hf = E_2 - E_1 = -10.2eV$$
$$\Rightarrow f = \frac{-10.2x1.6x10^{-19}}{6.6x10^{-34}}$$
$$\Rightarrow f = 2.5x10^{15}\,Hz$$

$$c = f\lambda$$
$$\Rightarrow \lambda = \frac{3x10^8}{2.5x10^{15}} = 1.2x10^{-7}\,m$$

or 120nm **(8)**