Year 12 Physics 2001
Assessment Task 5
Trial Examinations

Marking guidelines

Section I
Part A: Multiple Choice (1 mark each)

		Outcomes			Outcomes			Outcomes
1.	D	H9	6.	C	H1	11.	B	H2
2.	A	H9	7.	B	H9	12.	A	H9
3.	D	H6	8.	A	H9	13.	C	H10
4.	B	H13	9.	B	H9	14.	A	H9
5.	B	H6	10.	C	H9	15.	C	H2

Part B: Extended answers

Q.16. (3 marks)
Outcomes: H7, H13

- distance e.g. inverse square law for intensity of the signal in either direction (called 'space loss'). Special receiving devices are required to detect the weak signals. Also time delay of signals.
- Some frequencies are attenuated by the Earth's atmosphere, so microwave frequencies (which are not as attenuated as much as many other frequencies) are used.
- sunspot activity – sunspots are associated with the solar wind (a stream of charged particles, mostly protons & electrons streaming out from the sun). The solar wind affects the Earth's magnetic fields which in turn affects communication using electromagnetic radiation. When solar activity occurs, the radiation flux in the ionosphere is quite variable. Ionisation of gases will vary which refract the signals and will also cause scintillation which results in the signal varying in intensity and phase.
- van Allen radiation belts – two belts of charged particles (mostly protons & electrons) forming a donut-shape around the Earth). Solar activity can disrupt the van Allen belts. Changes in the magnetic field associated with the charged particles in the 'ring current' of the outer van Allen belt can cause interference of short wave radio communication and errors in communication satellites.

Marks: 1 mark each for any three points above (maximum of 3 marks).

Q.17.
Outcomes: H9

(a) Time of flight = 2 x time for rocket to reach maximum height (i.e. only the vertical component of the velocity is important for this).
Vertical motion:
To find time to maximum height (t):
If 'up' is +, then
$u_v = 80 \sin 35\ ms^{-1}$
$a_v = -9{,}8\ ms^{-2}$
$v_v = 0\ ms^{-1}$ (at maximum height)
$t = t$

$v_v = u_v + (a_v)t$
$0 = (80)(\sin 35) + (-9.8)t$
$t = 4.68$ s

Therefore, time of flight = 2 x t = **9.36s**

Marks:
- 1 mark for using correct vertical component of v
- 1 mark for correct formula and substitution
- ½ mark for 4.68 s

½ mark for 9.36 s

(b)
The range depends on the horizontal component of the velocity.
Horizontal motion:
If motion to the 'right' is +, then
$u_h = 80 \cos 35\ ms^{-1}$
$a_h = 0\ ms^{-2}$
$t = 9.36$ s
$s_h = s_h$ = Range
$\therefore$
$s_h = u_h.t$
$s_h = (80)(\cos 35)(9.36)$
$s_h =$ **613.38 m**

Marks:
- ½ mark for correct horizontal component of v
- ½ mark for 613.38 m

Q18.
Outcomes: H6

(a)
$t_v = s/v$
$t_v = 4.3/0.7 = 6.14$ yrs

$t_0 = t_v(1-v^2/c^2)^{0.5}$
$t_0 = 6.14(1 - 0.7^2c^2/c^2)^{0.5}$
$t_0 =$ **4.38 years**

Marks:
- 1 mark for 6.14 yrs
- ½ mark for correct equation
- ½ mark for 4.38 years

(b)
$L_v = L_0(1-v^2/c^2)^{0.5}$
$L_v = 4.3\ (1 - 0.7^2c^2/c^2)0.5$ (1 mark)
$L_v =$ **3.07 light years** (1 mark)

Marks:
- ½ mark for correct equation
- ½ mark for correct substitution
- 1 mark for 3.07 ly.

Q.19.

Outcomes: H2, H9, H11, H15

Marks:

- Appropriate labelled diagram (1 mark)
- Stating variables to be measured (1/2 mark)
- Stating quantities to be kept constant (& e.g. angle < 10°) (1/2 mark)
- Repeated measurements at same length (1 mark)

If length is varied:

- Graph to plot to obtain straight line (i.e. T^2 vs ℓ) (1 mark)
- How to use graph to obtain slope to calculate g. (slope = $g/4\pi^2$) (1 mark)

If length not varied:

- using formula to calculate g (1/2 mark)

Q.20.

Outcomes: H2, H7, H9, H13

The 'slingshot effect' (or 'gravity assist'):

- suitable diagram (before and after interaction with planet)

Explanation:

- *As the probe approaches the planet used for the 'slingshot effect', it speeds up due to the gravitational attraction, *relative to the planet*.
- *By Newton's 3rd Law, Venus will slow down in response, but because of its much greater mass, this is imperceptible.
- As the probe goes past the planet, it will slow down due to the gravitational attraction, *relative to the planet*.
- *However, the planet is rotating around the Sun, and its gravity drags the probe with it, causing it to increase its velocity *relative to the Sun* (as well as changing the probe's direction as required). The probe gains some of the angular momentum of the planet.

Marks:

- 1 mark for diagram.
- 1 mark for each point with a * and/or ½ mark for other point (maximum of 4 marks)

Q.21.

Outcomes: H7, H9, H13

(a) How the generator works:

- Steam or some other moving fluid would turn the turbine.
- This would induce a current in the coil of wire due to the magnetic field.
- The current would change direction every half cycle of rotation of the coil of wire producing an AC current, the frequency of which would be equal to the revolutions per second.
- The AC current flows through wires to slip rings which are attached to the carbon brushes. This allows the current to be accessed through the terminals.

Marks: 1 mark for each point or other appropriate points (maximum 4 marks)

(b)

The generator could be transformed into a DC generator by replacing the slip rings with a split ring commutator. This consists of two half cylinders connected to the wires from either end of the coil. These split rings are also connected to carbon brushes. They work by switching contact with each brush as the shaft rotates every half cycle. This ensures that the current flows in one direction only.

Marks: 1 mark for mentioning the split ring commutator.

Q.22.

Outcomes: H9, H13

$\tau = nIAB\cos\theta$

$\therefore$ in the graph of τ vs $\cos\theta$, the slope = nIAB

$\therefore B = \text{slope}/nIA$

Slope of graph = 1.1/0.02 = 55 Nm.

$B = \text{slope}/nIA = 55/(250)(2)(4 \times 10^{-2})(4 \times 10^{-2})$ = **69 T**

Marks:

If gradient of line of best fit used:

- ½ mark for line of best fit
- 1 mark for slope with units.
- 1 mark for slope = nIAB
- ½ mark for 69 T.
- subtract ½ mark if wrong order of magnitude
- subtract ½ mark if wrong or no units

If data points from graph used:

- 1½ mark if one point used.
- 2 marks if several points used and an average taken.
- subtract ½ mark if wrong order of magnitude
- subtract ½ mark if wrong or no units

Q.23.

Outcomes: H3, H4, H9, H13

- simple design
- low maintenance because there are no brushes to wear out as in other motors.
- induction motors have no sparking (sparking can be a problem in some circumstances e.g. if there

are flammable fumes around). • relatively low cost • the location of the coil relative to the magnets may affect starting (& starting direction) for conventional AC motors, but this is not a problem for induction motors. • suitable for domestic appliances
Marks: - 1 mark for any of above (to a maximum of 3 marks).

Q.24.
Outcomes: H7, H9, H13
(a) • Because the disk is spinning electrons in the metal are flowing. These are moving charged particles in a magnetic field so they will experience a force. Therefore they will move and other electrons will take their spot resulting in a current cycle. These cycles are called eddy currents and multiple eddy currents will be set up throughout the disk. • Because there is now a current flowing in the disk this will induce a force on the disk slowing it down (Lenz's law).
Marks: - 1 mark for production of eddy currents (½ if the term 'eddy currents' is not used in either (a) or (b)) - 1 mark for force opposing the motion and therefore slowing it down.
(b) The eddy currents may be overcome by cutting slits in the disk so that the electrons have nowhere to flow.
Marks: - 1 mark for slits in disc - 1 mark for explaining that this would reduce the ability of eddy currents to form.

Q.25.
Outcomes: H3, H4, H7, H9, H13
(a) $n_s/n_p = V_s/V_p$ $V_s = 240 \times 10 / 300$ $V_s = \underline{8\ V}$
Marks: - 1 mark for 8 V
(b) The transformer would not have worked at 100 % efficiency (in transferring energy from primary to secondary coils via the soft iron core connecting the coils) and therefore the potential difference across the secondary terminals would be lower than expected.
Marks: - 1 mark for loss of energy.
(c) • Some household appliances use a much smaller voltage than the mains 240 V (step-down transformer) e.g. a shaver has a small transformer in it; a laptop computer has an external transformer (external to reduce heating effects in the computer itself). • Some appliances require a much larger voltage (step-up transformer), e.g. the cathode ray tube of a TV set.
Marks: - 1 mark for statement that some appliances use voltages different from 240 V AC as supplied by the 'mains'. - 1/2 mark for step-down transformer - 1/2 mark for example using step-down - 1/2 mark for step-up transformer - 1/2 mark for example of step-up - ½ mark for safety explanation (Maximum of 3 marks)

Question 26

Outcomes: H1, H9, H13	
Criteria	**Marks**
Answers would provide a clear explanation of • the path of the cathode rays, • the use of the charged plates and the electromagnet, • the balancing of the forces on the cathode rays due to these • the measurement of relevant variables to determine the charge to mass ratio.	4
All 4 present but 1 or 2 errors minor errors or slight confusion	3.5
Only 3 of the 4 criteria above met (clear explanation)	3
Some information covering 3 criteria but with a number of errors and/or confusion	2.5
Only 2 of the criteria met (clear explanation)	2
Two criteria met but with a number of errors and/or confusion	1.5
Only one criterion met (clear explanation)	1

Question 27 Outcomes: H2, H8, H10, H13

(a)

Criteria	**Marks**
Answer indicates • waves to transfer energy - can explain electrons gaining energy • problem with threshold frequency • problem with effect of increased intensity answer needs to clearly indicate how wave model can or cannot explain photoelectric effect	4
Uses only two (must be one pro one con) and shows clearly how the wave model explains them or not.	3.5
Mentions all three but does not clearly indicate how the wave model does or does not explain them.	3
Uses only two (must be one pro one con) and does not clearly indicate how the wave model does or does not explain them	2.5
Uses two but both show inadequacy. Explanation clear and complete	2

Shows inadequacy of the model (one or two problems) but explanation unclear or contains errors.	1

(b)

Criteria	Marks
States that 1. light consists of photons (or particles) E = hf which is transferred to e's Explains clearly 2. threshold frequency using photon model 3. increase in KE of electrons when frequency increased.	3
All 3 stated/explained but a few errors or unclear in places	2.5
Only 2 and 3 of the above explained but done clearly	2
Two stated/explained but a few errors or unclear in places	1.5
Only one of 2 or 3 explained but done clearly	1
1 stated but no explanation	0.5

Question 28 Outcomes: H10, H13

Criteria	Marks
a) Describes starting material in terms of number of bonds (4) in solid b) Identifies doping involves adding small amounts of an element in group 3 (p type) or group 5 (n type) c) Describes effect in terms of bonding Covers all of these clearly	3
Covers all 3 but some confusion and/or a few errors	2.5
Covers a) and b) of the above but does so clearly	2
Covers a) and b) of the above but with some confusion or a few errors OR Covers all 3 but very confused and major errors OR Covers b) and c) clearly	1.5
Covers b) and c) with some confusion and/or a few errors OR Covers any 1 of the above but does so clearly	1
Covers any 1 of the above but with some confusion or errors	0.5

Question 29 Outcomes: H5, H3, H9, H13

a)

Criteria	Marks
Clear description of an application and an evaluation of its value compared to old technology	2
Description of an application that is not clear and an evaluation of its value compared to old technology	1.5
Clear description of an application but no evaluation of its value	1

Question 30 Outcomes: H3, H9, H13

a)

Criteria	Marks
States clearly meaning of term thermionic -heating of cathode giving energy to the electrons in the metal allowing them to move under the influence of the electric field.	1

b)

Criteria	Marks
At least 3 and from both sections Describes clearly similarities • allows current to flow in only one direction • electrons move under influence of electric field Describes clearly way in which devices differ • Size difference • No need for heating in semiconductor device • Difference in robustness • Time delay for thermionic device	3
Two comparisons only but one from each section	2.5
Three or more but from the one section	2
Two comparisons but from one section	1.5
One comparison	1

Section II (Option: From Quanta to Quarks) Marking Guidelines

Question 31

a)

Criteria	Marks
Refers to number neutrons in C-13. Compares the number of neutrons in C-13 to the number in a different isotope of carbon. OR Defines isotope in standard way (same number of protons, different number of neutrons) then uses C-13 as an example. Identifies number of neutrons and states a different isotope would have a different number of neutrons (no need to use C-12 or C-14 specifically)	1
Gives standard definition without reference to carbon	0.5

b) i)

Criteria	Marks
States • qualitatively relative size of gravitational and electrostatic forces, • larger force of repulsion and therefore a force needed to hold the nucleus together.	1
Misses one of the points above	0.5

ii)

Criteria	Marks
Any two of • force of attraction • short range • between all nucleons	2
One property only	1

c) i)

Criteria	Marks
At least 3 and from both sections Describes similarities clearly • Both consist of fission reactions • Neutron produced in one reaction goes on to cause another reaction Describe differences clearly • Average number of neutrons that cause further reactions • Rate of energy production	3
Two comparisons only but one from each section	2.5
Two comparisons but from one section	1.5
One comparison only	1

ii)

Criteria	Marks
Explains role of • moderator • control rods in maintaining average number of neutrons causing further fission at 1	3
Describes function of each but does not clearly explain effect on average number of neutrons causing further fission	2.5
Explains function of control rods only but explains clearly how they maintain chain reaction	2
Describes both in terms of slowing down or absorbing neutrons but does not attempt to link to effect on average number of neutrons causing further fission	1.5
Explains only one in terms of its effect on neutrons but not on chain reaction	1
Lists one or both parts with no further explanation	0.5

d)

Criteria	Marks
$^{241}_{94}Pu \longrightarrow {}^{237}_{92}Pa + {}^{4}_{2}He$	2
Minus 1 per mistake	

e)

Criteria	Marks
Mass of reactants = 236.052590 u Mass of products = 235.865095 u } 1 mark - 1 off per mistake Difference in mass = 0.187495 u 1 mark - 1 off per mistake 0.187495 u = 0.187495 x 931.5 Mev = 174.65 MeV (or 2.798×10^{-17} J) 1 mark 1 off per mistake 1 off for wrong units but only once in question	3

f) i)

Criteria	Marks
Clear and logical explanation • Initial theory that only daughter nucleus and beta particle produced • Fixed amount of energy released by radioactive decay which is carried away by the decay products • Little energy is taken by the large nucleus most of the energy should be taken by the electron • All the electrons should have the same amount of energy and close to the maximum released • There should not be a distribution of energies over the range from 0 to 1.7 • Energy distribution would break Law of Conservation of Energy if only 2 particles produced (2nd last point not essential)	3
All the points above but minor error or confusion OR 4 points only	2.5
4 points only but minor error or confusion OR 3 points only	2
3 points only but minor error or confusion OR 2 points only	1.5
States only that Law of Conservation of Energy broken	1

ii)

Criteria	Marks
Third decay product/neutrino proposed which took varying amounts of the energy produced	1
Existence of the neutrino proposed	0.5

g)

Criteria	Marks
• Extracted numerical data with correct units from the graph * • Identifies the dependent and independent variables • Identifies that increasing barrier thickness decreases the average count * • Identifies that the rate at which the count decreases is decreasing * • Recognises that the count does not appear to be approaching zero • Identifies that zero thickness is equivalent to count in air or with no barrier • Recognises background count and its likely effect on the counts * • Explains that increasing the thickness increases the chance of interaction with atoms in barrier	6
Points marked with * worth 1 mark Other points worth 1 mark	