

# Mark Scheme (Standardisation) Summer 2007

GCE

GCE Physics (6731/01)



## 6731 Unit Test PHY1

1.

**a**

Displacement and distance?

Displacement has direction distance doesn't or displacement is a vector distance is a scalar or an explanation in terms of an example eg A man walks 5 m south then 5 m north along the same line. The displacement = 0, distance = 10m

[Candidates who describe displacement as "measured from a point" but do not mention direction or equivalent do not get this mark] ✓

[Candidates must mention both displacement and distance to get this mark]

1 mark

**bi**

Position of train relative to A

300 m

✓

West (of) or a description eg In opposite direction/side (to where it started)

[Do not accept backwards, behind or negative displacement]

✓

2 marks

**bii**

Velocity against time graph

Constant velocity shown extending from  $t = 0$ , positive / negative

✓

[Above mark awarded even if graph does not reach or stop at  $t = 4\text{s}$ ]

Constant velocity shown beginning at  $t = 4\text{ s}$  and ending at  $t = 8\text{ s}$ , negative/positive (repectively)

✓

Values  $2.5\text{ (m s}^{-1}\text{)}$  or  $3.75\text{ (m s}^{-1}\text{)}$  or  $3.8\text{ (m s}^{-1}\text{)}$  seen [either calculated or on graph]

✓

[If candidates plot  $(4\text{ min, } 2.5\text{ ms}^{-1})$  or  $(8\text{ min, } 3.75 / 3.8\text{ ms}^{-1})$  award mark]

Both values [allow their values] correctly plotted using a scale

✓

[Only give this fourth mark if marking points 1 and 2 are correct. Also a clear scale must be seen eg 1, 2, 3, -1, -2, -3. The plot must be accurate to about half a small square.]

4 marks

**Total 7 marks**

2.

**a i**

Speed of spade at impact with soil

Selects correct equation ie  $v = u + at$  or 2 appropriate equations

✓

Correct substitution into equation

[Accept a substitution of  $-9.81 \text{ ms}^{-2}$ , only if it fits **their defined** positive convention]

✓

Answer

[to at least 2 sig. fig.,  $2.8 \text{ m s}^{-1}$ , no unit error. Allow use of  $g = 10 \text{ m s}^{-2}$  giving  $2.9 \text{ m s}^{-1}$ ]

✓

[Check that all working is correct for marks 2 and 3]

$$\begin{aligned}\text{Eg } v &= 9.81 \text{ m s}^{-2} \times 0.29 \text{ s} \\ &= 2.84 \text{ m s}^{-1}\end{aligned}$$

[This would get 3 marks even though the equation is not stated]

[Allow 2/3 for reverse argument – gives  $t = 0.3(05) \text{ s}$  with  $9.81 \text{ m s}^{-2}$  and  $0.3 \text{ s}$  with  $10 \text{ m s}^{-2}$ ]

3 marks

**a ii**

Acceleration in soil [Apply ECF]

Use of equation  $v^2 = u^2 + 2as$  or use of two appropriate equations

✓

[ignore power of 10 error and allow this mark even if they substitute the velocity value as  $v$  and not  $u$ ]

Magnitude of acceleration [ $78.4 \text{ (m s}^{-2}\text{)}$ ,  $80.7 \text{ (m s}^{-2}\text{)}$  or  $81 \text{ (m s}^{-2}\text{)}$  if  $2.84 \text{ m s}^{-1}$  used;  $84.1 \text{ (m s}^{-2}\text{)}$  if  $2.9 \text{ m s}^{-1}$  is used;  $90 \text{ (m s}^{-2}\text{)}$  if  $3 \text{ m s}^{-1}$  is used]

✓

[Check that all working is correct for mark 2]

Correct sign [ minus ] and unit

[Only award this mark for correct substitution into equation or equations]

✓

$$\begin{aligned}\text{Eg } 0 &= (2.8 \text{ m s}^{-1})^2 + 2a \times 0.29 \text{ m} \\ a &= -78.4 \text{ m s}^{-2}\end{aligned}$$

3 marks

**b**

Change in impact speed and acceleration in soil

Speed – the same

✓

Acceleration – a lower

✓

2 marks

**Total 8 marks**

3.

ai

How constant measurable force is applied

Newtonmeter/forcemeter pulled (to constant reading) or elastic band (pulled to fixed extension )

[ Allow a mass on the end of a string as the force, even if they do not make it clear that the mass being accelerated includes this mass] [Do not allow a ramp at a fixed angle] ✓

1 mark

aii

Ticker tape	Light gate/sensor	Motion sensor	Video / strobe
Ticker timer	Connected to timer / datalogger / PC	Datalogger /PC	Metre rule / markings on the track

[Do not give allow first 2 marks for ruler and stopwatch]

✓✓

Description of distance measured and corresponding time or any mention of  $v = \frac{d}{t}$  ✓

[Remember to also look at **labelled** diagram for these marks. Give this mark even if they have not obtained the first two marks]

3 marks

b

Additional measurements required for acceleration

Another velocity [accept 'final velocity'] measurement or zero velocity at start ✓

[Accept mention of double interrupter for first mark]

**Either distance between velocity measurements / distance to single velocity measurement**

[If zero velocity is given for first marking point] ✓

**Or time between velocity measurements / time to single velocity measurement from start**

✓

[It must be reasonably clear what distance or time they are using to award this mark]

Max 2 marks

**c**

### How relationship is shown

Divide  $\frac{\text{(Applied)Force}}{\text{acceleration}}$  for each pair of measurements or Plot graph of (applied) force v acceleration ✓

Ratio should give same value or graph gives straight line **through origin**  
[could obtain these marks from a sketch mark]

[Watch out for descriptions where acceleration is multiplied by the measured mass of the trolley. This is then taken as the applied force, which is plotted against the acceleration. Give no marks for this]

[A statement “force is proportional to acceleration” would not get these marks]

2 marks

**d**

### Why effect of friction must be eliminated

(In Newton's law) the force referred to is the resultant force / unbalanced force / accelerating force acting on an object / a description of the resultant force ✓

(If friction is not compensated for) the (measured) force would be greater than/not equal to the resultant force (by an amount equal to that needed to overcome friction) or the (measured) force would also have to overcome friction

[Accept 'friction will reduce the acceleration' for this mark]

[An example where 2 marks can be awarded:      Resultant Force = ma  
(Applied) Force – Friction = ma      ]

["Some additional force must be made to gain the same acceleration as if there was no friction" would only attain the second mark because they haven't told us that the second law requires the resultant force]

2 marks

**Total 10 marks**

4.

**a**

Weight of pen

Weight = mg seen or used  
[ignore power of 10 error]

✓

Answer [ 0.11 N]

✓

Eg Weight =  $0.011 \text{ kg} \times 9.81 \text{ m s}^{-2}$   
= 0.108 N

2 marks

**bi**

Add labelled arrow to represent weight

Arrow pointing down at 8 cm **labelled** weight (of pen) /0.11 N /W/mg /their value

✓

[Check by eye. Arrow will be along the vertical line of the last letter 'd' in the word 'balanced' in the line above]

1 mark

**bii**

Calculate weight of top(ecf their value of weight)

Use of principle of moments i.e. a clockwise moment equal to an anti-clockwise moment

✓

[Give this mark even if distances are wrong, but must use 0.11 N / their value]

Correct distances used [must be 1 cm and 4cm, no ECF from bi]

✓

Answer [ 0.03 N ]

✓

Eg  $0.11 \text{ N} \times 1 \text{ cm} = W \times 4 \text{ cm}$   
 $W = 0.0275 \text{ N}$

[Only penalise same unit error once]

3 marks

Description of force and why it produces no moment

ci

At the pivot, upwards

✓

cii

Magnitude [0.14 N. Ecf their value of weight ]

✓

Eg magnitude =  $0.03 \text{ N} + 0.11 \text{ N} = 0.14 \text{ N}$

[If they add their numerical value in (a) to their answer in (bii), give this mark eg  $108 + 27 = 135 \text{ N}$ . 135 kg is wrong]

[Only penalise same unit error once]

ciii

Line of action acts through pivot / (perpendicular) distance to pivot is zero/force is through or at pivot

✓

3 marks

**Total 9 marks**



**5.**

Complete statements

**ai**

.....tyre/ wheel ..... road(surface)

✓

**aii**

.....road(surface) ..... tyre

✓

2 marks

**bi**

Power

Use of power =  $Fv$

✓

Answer [4000W]

✓

Eg Power =  $400 \text{ N} \times 10 \text{ m s}^{-1}$   
=  $4000 \text{ W}$  [or  $\text{J s}^{-1}$  or  $\text{N m s}^{-1}$ ]

2 marks

**bii**

Work done( ecf their value of power)

Answer [ $1.2 \times 10^6 \text{ J}$ ]

✓

Eg Work done =  $4000 \text{ W} \times 5 \times 60 \text{ s} = 1.2 \times 10^6 \text{ J}$  [or  $\text{N m}$ ]

1 mark

**c**

Why no gain in  $E_k$

**Either**

(All the)Work done is being transferred [not lost or through] to thermal energy [accept heat] / internal energy (and sound)

✓

Overcoming friction ( within bearings, axle, gear box but not road surface and tyres) / air resistance / resistive force/ drag

✓

[The information in the brackets is of course not essential for the mark. However, if a candidate refers to friction between the road surface and the tyre do not give this mark]

[Watch out for statements such as “because work is used up to cancel out the friction being applied on the car”. Give no marks for this because energy is being equated to a force]

**Or** (allow the following)

Driving force is equal to resistive force / friction / air resistance / drag or unbalanced force is zero ✓

(Therefore) acceleration is zero (hence no change in speed therefore no change in ke) ✓

2 marks

**Total 7 marks**

**6.c**

Atomic symbols

**a**

Isotope(s)

✓

**b**

Both nucleon numbers correct ie 131 and 123 / a fully correct symbol

✓

Both proton numbers correct ie both 53 / a fully correct symbol

✓

[The correct symbols are  $^{131}_{53}\text{I}$ ,  $^{123}_{53}\text{I}$ ]

[Do not accept  $^{53}_{131}\text{I}$ ,  $^{53}_{123}\text{I}$ ]

**c**

Nucleon number – reduced by/loses/ goes down by/ decreased by 4,

Proton number - reduced by/loses/ goes down by/ decreased by 2

[ allow -4 and -2 but not just 4 and 2]

✓

**Total 4 marks**

7.

**a**

Size of diameter

**Either**

Working / value to show how many atoms per side

$$[\sqrt[3]{10^{21}} / 10^7 \text{ atoms}]$$

✓

Working / value to give side length

$$[\sqrt[3]{8 \times 10^{-9} \text{ (m}^3\text{)}} / 2 \times 10^{-3} \text{ (m)}]$$

✓

$$\text{Answer } [\frac{2 \times 10^{-3} \text{ m}}{10^7} = 2 \times 10^{-10} \text{ m}]$$

✓

**Or**

Working / value to give vol. of each atom

$$[\frac{8 \times 10^{-9} \text{ (m}^3\text{)}}{10^{21}} = 8 \times 10^{-30} \text{ (m}^3\text{)}]$$

✓

Working to find diameter

$$[\text{set vol.} = \frac{4}{3} \pi r^3 \text{ or } \sqrt[3]{8 \times 10^{-30} \text{ (m}^3\text{)}}]$$

✓

$$[\text{Do not accept } 8 \times 10^{-9} \text{ m}^3 = \frac{4}{3} \pi r^3]$$

$$\text{Answer } [2.4(8) \times 10^{-10} \text{ m or } 2 \times 10^{-10} \text{ m}]$$

✓

$$[\text{Allow } 1.2(4) \times 10^{-10} \text{ m}]$$

3 marks

**b**

Show that the nuclear density is  $10^{13}$  times greater

QWOC

✓

[When this mark is not awarded, mark through the word “clarity” in the rubric of the question]

(Essentially) the (entire) mass[allow weight] of the atom(s) is concentrated in the nucleus  
[eg ‘most of the mass of the atom is in the nucleus’. ‘the mass of the nucleus = the mass of the atom’]

✓

Any reference or use of the density equation

[Not the magic triangle]

✓

Argument to show density is  $10^{13}$  greater

✓

$$\text{eg } 2300 = \frac{M}{V}, D_{\text{nucleus}} = \frac{M}{10^{-13} V} = 10^{13} \times 2300$$

[Give this last mark if they refer to the density of the atom as a symbol rather than  $2300 \text{ kg m}^{-3}$ ]

4 marks

**Total 7 marks**

8.

a

Meanings

**Spontaneous:** Happens independently of / cannot be controlled by / unaffected by chemical conditions/ physical conditions/temperature/ pressure or without stimulation/without trigger. ✓

[Do not accept random/cannot be predicted]

**Radiation:** alpha, beta and gamma and positron ✓

[give the mark if they name **one** of these]

[Accept em wave from nucleus]

**Unstable:** (Nuclei) [not atoms] are (liable) to break up / decay / disintegrate or nucleus has too much energy or too many nucleons [not particles]/may release radiation ✓

[for this mark do not accept 'nucleus has high energy' or '..has many particles']

[Accept binding force is not sufficient]

[Accept too many or too few protons/neutrons]

3 marks

bi

Half life

Evidence of average calculated ie have used more than just one value ✓

[ Make sure to look at graph, if 2 sets of lines are seen, award this mark, even if there is no evidence in written answer]

Answer [ (5.6 – 6) hours (20160 s – 21600 s)]

✓  
2 mark

bii

Decay constant

Answer [Accept answers in the range  $3.10 - 3.45 \times 10^{-5} \text{ s}^{-1}$  /  $0.11(5) - 0.12(3) \text{ h}^{-1}$ ]

[ecf their value of half life]

[Do not accept Bq]

✓

$$\text{Eg } \lambda = \frac{0.69}{6 \times 3600 \text{ s}} / \frac{0.69}{6 \text{ h}} = 3.19 \times 10^{-5} \text{ s}^{-1} / 0.12 \text{ h}^{-1}$$

1 mark

**iii**

Number of atoms

Use of  $|A| = \lambda N$  [ignore power of 10 errors and use of  $0.12 \text{ h}^{-1}$ , ecf their value of decay constant]

✓

Answer [ in range  $1.5 - 1.6 \times 10^{11}$  ]

✓

$$\begin{aligned} \text{Eg } N &= \frac{0.5 \times 10^7 \text{ Bq}}{3.2 \times 10^{-5} \text{ s}^{-1}} \\ &= 1.56 \times 10^{11} \end{aligned}$$

2 marks

**Total 8 marks**