

# Mark Scheme

## 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.

[Candidates who describe displacement as "measured from a point" but do not mention direction or equivalent do not get this mark] ✓ 1

(b)(i) Position of train relative to A

300 m ✓

West (of) or a description  
[Do not accept backwards, behind or negative displacement] ✓ 2

(b)(ii) 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  $t = 4$  min]

Constant velocity shown beginning at  $t = 4$  min and ending at  $t = 8$  min, negative/positive (respectively)

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]

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.]

$\frac{4}{7}$

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  $-9.81 \text{ m s}^{-2}$ , 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]

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

[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

(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  $u$ ]

[If acceleration of freefall used for acceleration, award 0/3]

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  $2.84 \text{ m s}^{-1}$  is 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 ✓

3

[Only award this mark if there has been correct substitution into equation or equations]

$$\text{Eg } 0 = (2.8 \text{ m s}^{-1})^2 + 2a \times 5 \times 10^{-2} \text{ m} \\ a = -78.4 \text{ m s}^{-2}$$

(b) Change in impact speed and acceleration in soil

Speed - the same

Acceleration - a lower

$\frac{2}{8}$

3 (a) How constant measurable force is applied

(i)

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] ✓

1

(a)

(ii)

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

[A labelled diagram can get both these marks.] ✓✓

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

Description of distance measured and corresponding time or any

mention of  $v = \frac{d}{t}$  ✓

3

[Give this mark even if they have not obtained the first two 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 clear what distance or time they are using to award this mark] ✓

2

(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 graph]

2

[A statement "force is proportional to acceleration" would not get these 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]-

$\frac{2}{10}$

4 (a)	<u>Weight of pen</u>		
	Weight = mg seen or used [ignore power of 10 error]	✓	
	Answer [ 0.11 N]	✓	2
	Eg Weight = $0.011 \text{ kg} \times 9.81 \text{ m s}^{-2}$ = 0.108 N		
(b)(i)	<u>Add labelled arrow to represent weight</u>		
	Arrow pointing down at 8 cm labelled weight (of pen) /0.11 N /W/mg [Check by eye]	✓	1
(b)(ii)	<u>Calculate weight of top</u> (ecf their value of weight)		
	Use of principle of moments	✓	
	[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 ]	✓	3
	Eg $0.11 \text{ N} \times 1 \text{ cm} = W \times 4 \text{ cm}$ $W = 0.0275 \text{ N}$		
	<u>Description of force and why it produces no moment</u>		
(c)(i)	At the pivot, upwards	✓	
(c)(ii)	Magnitude [0.14 N. Ecf their value of weight]	✓	
	Eg magnitude = $0.03 \text{ N} + 0.11 \text{ N} = 0.14 \text{ N}$		
(c)(iii)	Line of action acts through pivot / force is through or at pivot or (perpendicular) distance to pivot is zero	✓	3
			<u>6</u>

5 (a)	<u>Complete statements</u>		
	.....tyre/ wheel ..... road(surface)	✓	
(a)(ii)	.....road(surface) ..... tyre/wheel	✓	
			2
(b)(i)	<u>Power</u>		
	Use of power = Fv	✓	
	Answer [4000W]		
	Eg Power = 400 N x 10 m s <sup>-1</sup> = 4000 W [or J s <sup>-1</sup> or N m s <sup>-1</sup> ]	✓	
			2
(b)(ii)	<u>Work done</u> (ecf their value of power)		
	Answer [1.2 x 10 <sup>6</sup> J ]		
	Eg Work done = 4000 W x 5 x 60 s) = 1.2 x 10 <sup>6</sup> J [or N m]	✓	
			1
(c)	<u>Why no gain in E<sub>k</sub></u>	✓	
	Either		
	(All the)Work (done)/energy 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	✓	2
	[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]		
	Or (allow the following)	✓	
	Driving force is equal to resistive force / friction / air resistance / drag or unbalanced force is zero or forces in equilibrium	✓	
	(Therefore) <u>acceleration</u> is zero (hence no change in speed therefore no change in ke)		2
			7

6 (a) Atomic symbols

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  ${}_{53}^{131}\text{I}$ ,  ${}_{53}^{123}\text{I}$ ]

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

(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]

4

7 (i) 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 ✓

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

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 ✓

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

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

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

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

3

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

QWOC ✓

(Essentially) the (entire) mass [allow weight] of the atom(s) is concentrated in the nucleus ✓

Any reference or use of the density equation ✓

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

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

$\frac{4}{7}$

- 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]

- (ii) **Radiation:** alpha, beta and gamma and positron [give the mark if they name one of these] ✓

**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/[Accept] binding force is not sufficient/[Accept] binding energy is not sufficient/[Accept] too many/too few protons/neutrons

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

Half life ✓

3

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

- (b)(i) [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)] ✓

Decay constant

Answer [Accept answers in the range  $3.1 - 3.5 \times 10^{-5} \text{ s}^{-1}$  /  $0.11(5) - 0.12(3) \text{ h}^{-1}$ ] ✓

2

[ecf their value of half life]

- (b)(ii) [Do not accept Bq for the unit] ✓

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

Number of atoms

Use of  $A = \lambda N$

Answer [in range  $(1.50 - 1.65) \times 10^{11}$ ]

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

3  
6

