Centre No.						Paper Reference	Surname	Initial(s)
Candidate No.						6 7 3 1 / 0 1	Signature	

Paper Reference(s)

6731/01

Edexcel GCE

Physics

Advanced Subsidiary

Unit Test PHY1

Friday 10 June 2005 – Morning

Time: 1 hour 15 minutes

Materials required for examination	Items included with question papers
Nil	Nil

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
8	
Total	

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your signature, your surname and initial(s).
Answer **ALL** questions in the spaces provided in this question paper.
In calculations you should show all the steps in your working, giving your answer at each stage.
Calculators may be used.
Include diagrams in your answers where these are helpful.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets.
There are eight questions in this paper. The total mark for this paper is 60.
The list of data, formulae and relationships is printed at the end of this booklet.

Advice to Candidates

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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N 2 1 0 6 5 A 0 1 1 6

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1. Complete the table to show the missing physical quantity for each unit.

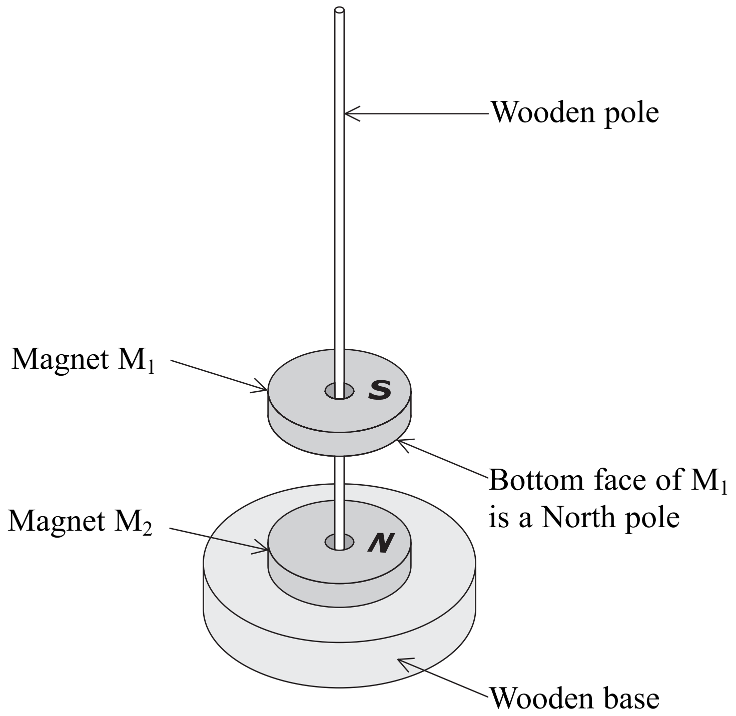
Unit	Physical quantity
m s^{-1}	Velocity
m s^{-2}	
kg m^{-3}	
N m	
kg m s^{-1}	
N m s^{-1}	

Q1

(Total 5 marks)

Leave blank

2. The diagram shows two magnets, M_1 and M_2, on a wooden stand. Their faces are magnetised as shown so that the magnets repel each other.



(a) Draw a fully labelled free-body force diagram for the magnet M_1 in the space below.

(2)

N 2 1 0 6 5 A 0 4 1 6

Leave blank

(b) The table gives the three forces acting on the magnet M_2. For each force on M_2 there is a corresponding force known as its 'Newton's third law pair'. In each case state

(i) the body on which this corresponding force acts,

(ii) the direction of this corresponding force.

Force on M_2	Body on which corresponding force acts	Direction of the corresponding force
Contact		
Magnetic		
Weight		

(6) **Q2**

(Total 8 marks)

N 2 1 0 6 5 A 0 5 1 6

Leave blank

3. (a) State the principle of moments.

....

....
(2)

(b) A metal bar has dimensions width 1.2 cm, thickness 0.60 cm and length 200 cm. The metal has a density of 8.0 g cm^{-3}.

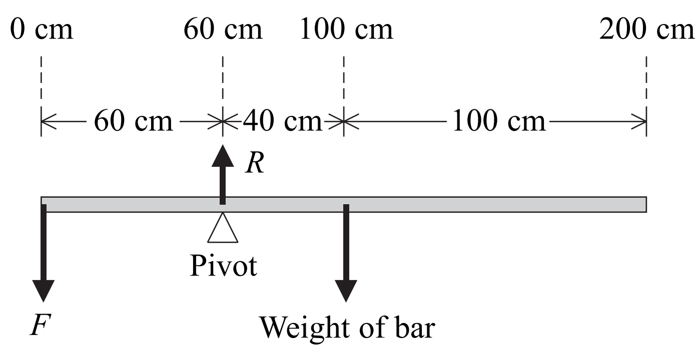
(i) Show that the weight of the bar is about 11 N.

....

....

....
(3)

The bar is placed on a pivot and kept in equilibrium by the forces shown.



(ii) Use the principle of moments to calculate the force *F*.

....

....

....

Force *F* = ...
(2)

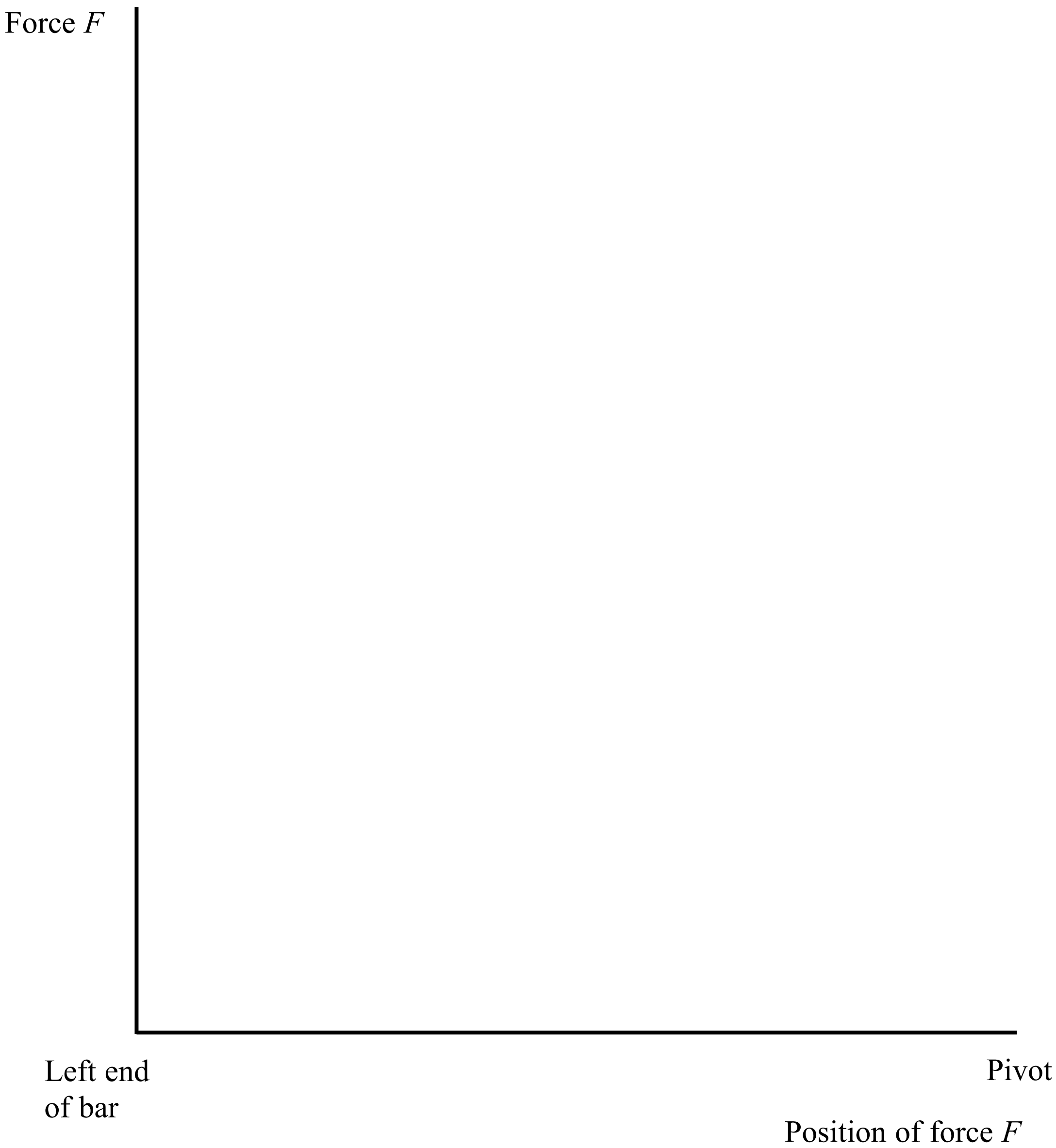
(iii) Calculate the force *R*.

....

Force *R* = ...
(1)

N 2 1 0 6 5 A 0 6 1 6

(iv) The force F is moved towards the pivot. On the axes below sketch how the force F must vary to keep the bar in equilibrium.



(2)

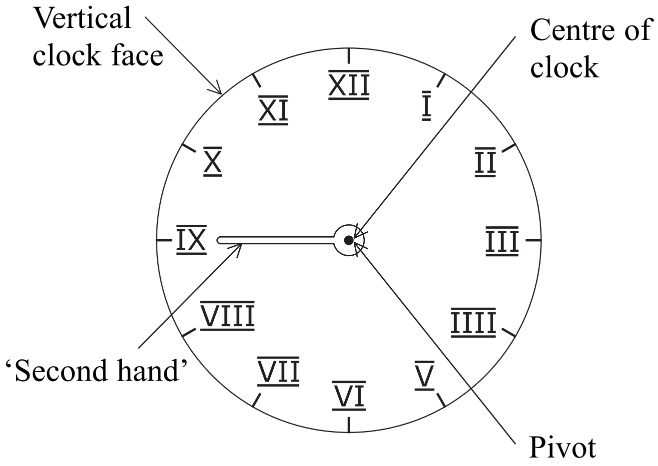
(Total 10 marks)

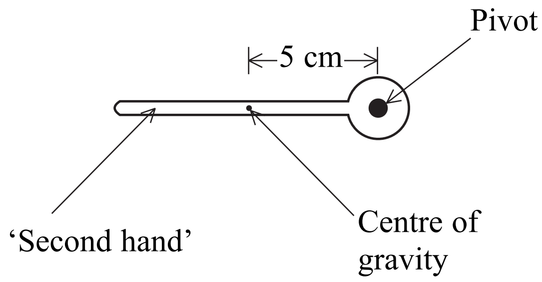
Leave blank

Q3

Leave blank

4. The diagram shows the 'second hand' of a clock whose face is vertical. This hand rotates once every 60 s.





This 'second hand' has a mass of 1.0×10^{-4} kg. Its centre of gravity is 5.0 cm from the pivot as shown on the diagram.

(a) Calculate the moment of the 'second hand' about the pivot when at the position shown above.

....

....

....

Moment = ...

(2)

(b) The clock mechanism lifts the 'second hand' during the next second.

Show that the work done against the gravitational force by the mechanism during this second is approximately 5×10^{-6} J.

....

....

....

....

....

....

(3)

N 2 1 0 6 5 A 0 8 1 6

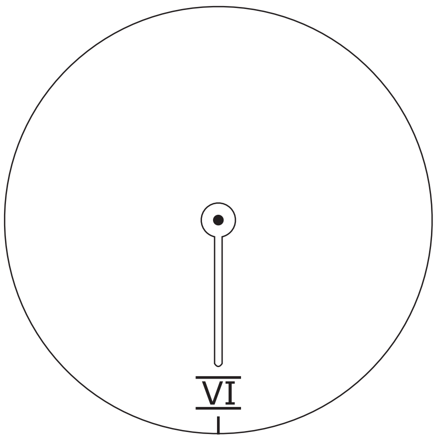
(c) The work done against gravitational force when the 'second hand' moves in the second immediately before the XII position is much smaller than 5×10^{-6} J. Explain why.

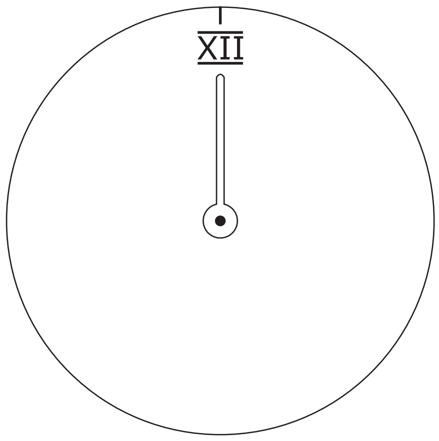
....

....
(1)

(d) Calculate the average power needed to move the 'second hand' from the VI position (Figure 1) to the XII position (Figure 2). Neglect any work done against forces other than the gravitational force.

Figure 1 **Figure 2**





....

....

....

....

....

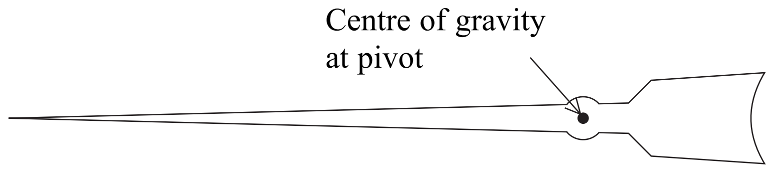
Average power = ...
(2)

Leave blank

N 2 1 0 6 5 A 0 9 1 6

Leave blank

(e) The diagram below shows a different design for the 'second hand'.



Explain why this design would require less power.

....

....

....
(2)

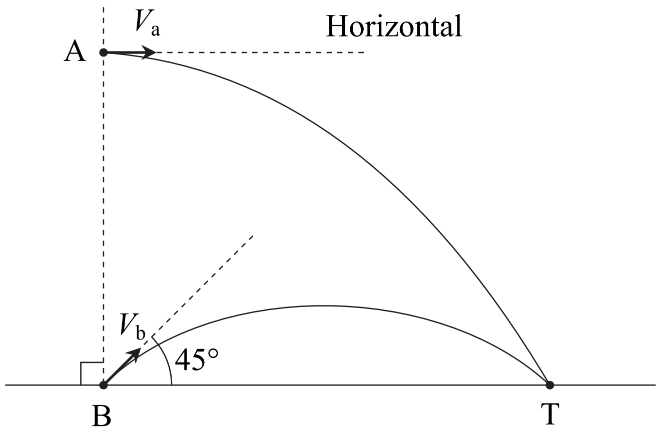
Q4

(Total 10 marks)

N 2 1 0 6 5 A 0 1 0 1 6

Leave blank

5. A student is investigating projectiles. He fires two small identical balls, A and B, simultaneously. Their trajectories are shown in the sketch below. The balls land at the same instant at the target, T.



(a) The initial velocity of ball A is V_a and that of ball B is V_b. Explain why the magnitude of V_b must be greater than that of V_a.

....

....

(b) The paths AT and BT have different lengths. However, balls A and B take the same time to reach the target T. Explain how this is possible. You may be awarded a mark for the clarity of your answer.

....

....

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....

....

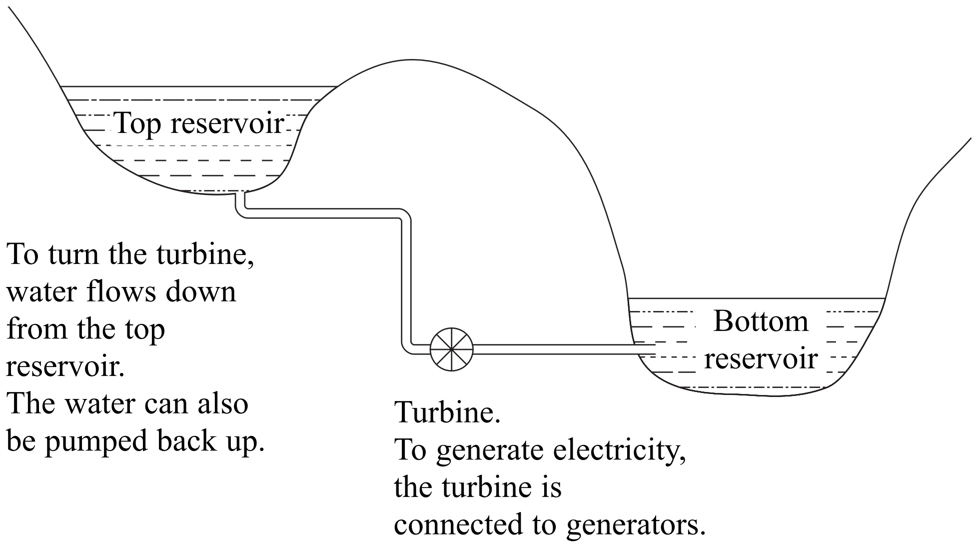
....

Q5

(Total 5 marks)

Leave blank

6. A certain power station generates electricity from falling water. The diagram shows a simplified sketch of the system.



(a) (i) In what form is the energy of the water initially stored?

....

(ii) What energy form is this transformed into in order to drive the turbine?

....

(1)

(b) State the principal of conservation of energy.

....

....

....

(2)

(c) The force of the water at the turbine is 3.5×10^8 N and the output power generated is 1.7×10^9 W. Use this data to calculate the minimum speed at which the water must enter the turbine.

....

....

(2)

(d) Explain why, in practice, the speed at which the water enters the turbine is much greater than this.

....

....

(1)

N 2 1 0 6 5 A 0 1 2 1 6

Leave blank

(e) When working at this output power, $390\ m^3$ of water flows through the turbine each second. The top reservoir holds $7.0 \times 10^6\ m^3$ of water. For how long will electricity be generated?

....

....

....

Time = ...

(1)

(f) This power station is used at peak periods, after which the water is pumped back to the top reservoir. The water has to be raised by 500 m. How much work is done to return all the water to the top reservoir?

(The density of water is $1000\ kg\ m^{-3}$.)

....

....

....

....

....

Work done = ...

(3)

Q6

(Total 10 marks)

Leave blank

7. The first artificially produced isotope was the isotope phosphorus ${}^{30}_{15}\text{P}$. This was formed by bombarding aluminium Al with α-particles.

(a) (i) Complete the equation to show the missing nucleon and proton numbers:

$$^{\cdots\cdots}_{\cdots\cdots}\text{Al} + {}^{\cdots\cdots}_{\cdots\cdots}\alpha \rightarrow {}^{30}_{15}\text{P} + {}^{1}_{0}\text{n}$$

(2)

(ii) ${}^{30}_{15}\text{P}$ decays to a stable isotope of silicon ${}^{30}_{14}\text{Si}$ by the emission of a further particle, X. Complete the following equation to show the missing nucleon and proton numbers:

$$^{30}_{15}\text{P} \rightarrow {}^{30}_{14}\text{Si} + {}^{\cdots\cdots}_{\cdots\cdots}\text{X}$$

Suggest what the particle X is.

....

(2)

(b) The half-life of the radioactive isotope of phosphorus ${}^{30}_{15}\text{P}$ is 195 seconds. Give the meanings of the terms **half-life** and **isotope**.

Half-life ....

....

Isotope ....

....

(3)

(c) Atoms which emit α- or β-particles usually emit γ-rays as well. Explain why this occurs.

....

....

....

....

....

(1)

Q7

(Total 8 marks)

Leave blank

8. When electrons are fired at nucleons many of the electrons are scattered.

When the electrons have low energy, the scattering is elastic.

However, when the electrons have sufficiently high energy, deep inelastic scattering occurs.

(a) What is meant by **inelastic** in this situation?

....

....

(1)

(b) What is revealed about the structure of the nucleon by deep inelastic scattering?

....

....

(1)

(c) What quantity is conserved during both elastic and inelastic scattering?

....

(1)

(d) Historically, physicists found that electrons of low energy could not be used to find out information about the nucleus of neutral atoms. Suggest why.

....

....

(1)

Q8

(Total 4 marks)

TOTAL FOR PAPER: 60 MARKS

END

N 2 1 0 6 5 A 0 1 5 1 6

List of data, formulae and relationships

Data

Speed of light in vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	
Acceleration of free fall	$g = 9.81 \text{m s}^{-2}$	(close to the Earth)
Gravitational field strength	$g = 9.81 \text{ N kg}^{-1}$	(close to the Earth)

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$

$$x = ut + \tfrac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

Forces and moments

Moment of F about O $= F \times$ (Perpendicular distance from F to O)

Sum of clockwise moments about any point in a plane = Sum of anticlockwise moments about that point

Dynamics

Force $F = m\dfrac{\Delta v}{\Delta t} = \dfrac{\Delta p}{\Delta t}$

Impulse $F\Delta t = \Delta p$

Mechanical energy

Power $P = Fv$

Radioactive decay and the nuclear atom

Activity $A = \lambda N$ (Decay constant λ)

Half-life $\lambda t_{\frac{1}{2}} = 0.69$

Experimental physics

$$\text{Percentage uncertainty} = \frac{\text{Estimated uncertainty} \times 100\%}{\text{Average value}}$$

Mathematics

$$\sin(90° - \theta) = \cos\theta$$

Equation of a straight line $y = mx + c$

Surface area cylinder $= 2\pi rh + 2\pi r^2$

sphere $= 4\pi r^2$

Volume cylinder $= \pi r^2 h$

sphere $= \tfrac{4}{3}\pi r^3$

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

$\cos\theta \approx 1$