AS Physics - Experiment Questions for Unit 1 Mark Scheme

1. Draw a labelled diagram of the apparatus you would use to measure the acceleration of a body in free fall.

Diagram showing

relevant distance
timing devices
disposition of equipment

(3 marks)

List the measurements you would make and show how you would use them to calculate the acceleration.

measure and record which distance
measure and record which time
repeat for other distances
graph of distance against time^2
acceleration of free fall
equals twice the gradient

(5 marks)
[Total 8 marks]

2. State Newton's second law of motion.

Magnitude of forces proportional to rate of change of momentum (1) and direction of force same as the direction of the change in momentum (1).

(2 marks)

You are asked to test the relation between force and acceleration.

Draw and label a diagram of the apparatus you would use.

Diagram showing

1. how a range of quantifiable forces can be applied to a movable object of constant mass (1)

and

2. equipment suitable for measuring the acceleration (1).

State clearly how you would use the apparatus and what measurements you would make.

A statement of how the magnitude of the variable force is known. (1)
The identification of the distance and (1)
time measurements that could yield a value for the acceleration (1)
Repeat the acceleration measurements for different forces (1)

(6 marks)

Explain how you would use your measurements to test the relationship between force and acceleration.

Method of determining the acceleration from the distance and time measurements. (1)
Draw a graph of force against acceleration. (1)
Proportionality indicated by a straight line passing through the origin. (1)

(3 marks)
[Total 11 marks]

3. Diagram:
Shown and labelled
Ticker timer at top **or** Strobe light **(1)**
Tape from trolley through timer **or** camera [consequent] **(1)**
OR
Motion sensor pointing at trolley **or** video **(1)**
Connection to datalogger/computer or rule [both consequent] **(1)**
OR
Three or more light gates **(1)**
Connection to datalogger/computer [consequent] **(1)**
[**Two** light gates connected to 'timer' – max 1]
[Rule **and** stop clock - max 1]

Values for υ and a: 2
0.95 m s^{-1} [2 s.f.] **(1)**
Use of gradient or formula **(1)**
0.79 m s^{-2} [no e.c.f. if u = 0] **(1)**
Distance AB: 3
AB = 'area' under graph, or quote appropriate equation of motion **(1)**
Physically correct substitutions **(1)**
0.86 m [allow 0.9 m] [e.c.f. wrong u or a] **(1)**
Graph: 3
Smooth curve rising from origin, getting steeper **(1)**
Initial gradient non-zero [consequent] **(1)**
(0.70, 0.86) matched (e.c.f. on distance) **(1)** 3

[11]

4. Explanation

Some energy converted to internal energy [or heat or sound] / work done against friction [or air resistance] **(1)** 1

Experiment

Measure υ at the bottom **(1)**

Suitable apparatus, e.g. motion sensor and data logger/light gate(s) and timer or computer **(1)**

Detail of technique, e.g. sensor sends pulses at regular time intervals and time to return is measured/gate measures time for card of known length to pass/tickertape measures length between dots made at regular time intervals **(1)**

Measure mass of trolley with balance **(1)**

Calculate kinetic energy from $m\upsilon^2/2$ **(1)**

Measure vertical drop with ruler **(1)**

Calculate (gravitational) potential energy from *mgh* **(1)**

Calculate $\frac{\text{ke}}{\text{gpe}} \times 100$ Max 6

[7]

5. Crosses on graph:

P at end of straight line section **(1)**

Y – accept between P and maximum force value **(1)** 2

Young modulus calculation:

Calculation of stress (with force up to 1000 N)

$= \frac{F}{A} = \frac{1 \times 10^{3}\ \text{N}}{3 \times 10^{-5}\ \text{m}^{2}} = 3.3 \times 10^{7}\ (\text{N m}^{-2})$ **(1)**

Calculation of strain (with corresponding extension from straight line graph)

$= \frac{x}{L} = \frac{0.2\ \text{m}}{4.0\ \text{m}} = 0.05$ **(1)**

$E = \frac{\text{stress}}{\text{strain}} = \frac{3.3 \times 10^{7}\ \text{N m}^{-2}}{0.05} = 6.7 \times 10^{8}\ \text{Pa}$ **(1)** 3

Lines on graph:

(i) *L* graph: twice extension for given force [Ignore end] **(1)**

(ii) *A* graph: 3 × force for given extension [Ignore end] **(1)**

Reasoning based on rearranged equation e.g. $F = Eax/L$ and *E* constant implied in:

2*L* gives 2*x* for same *F* **(1)**

3*A* gives 3*F* for same *x* **(1)** 4

Energy stored in the rope:

Energy = ½ *Fx* = ½ × 1000 N × 0.2 m **(1)**

= 100 J **(1)** 2

Why a longer rope is less likely to break:

Any one point from:

- greater extension for same force
- larger area under graph
- more energy stored 1

[12]