Equations of Motion

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Kinematics
Sub Topic	Equations of Motion
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **69 minutes**

Score: **/57**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** e.g. initial speed is zero
constant acceleration
straight line motion
(*any two, one mark each*) ……B2 [2]

(b) **(i)** $s = ½a\,t^2$
$0.79 = ½ \times 9.8 \times t^2$ …….. C1
t = 0.40 s allow 1 SF or greater ……. A1
2 or 3 SF answer …….. A1 [3]

(ii) distance travelled by end of time interval = 90 cm ……. C1
$0.90 = ½ \times 9.8 \times t^2$
t = 0.43 s allow 2 SF or greater ……. C1
time interval = 0.03 s ……... A1 [3]

(c) (air resistance) means ball's speed/acceleration is less ……. M1
length of image is shorter ……. A1 [2]

2 **(a** **(i)** $v^2 = 2as$
$v^2 = 2 \times 0.85 \times 9.8 \times 12.8$ C1
$v = 14.6\ \text{m s}^{-1}$ A1 [2]

(ii) time = 29.3 / 14.6 C1
= 2.0 s A1 [2]
(*any acceleration scores 0 marks; allow 1 s.f.*)

(b) *either* $60\ \text{km h}^{-1} = 16.7\ \text{m s}^{-1}$
or $14.6\ \text{m s}^{-1} = 53\ \text{km h}^{-1}$
or $22.1\ \text{m s}^{-1} = 79.6\ \text{km h}^{-1}$ M1
so driving within speed limit A1
but reaction time is too long / too slow B1 [3]

3 **(a** **(i)** $v^2 = 2as$
$1.2^2 = 2 \times a \times 1.9$ M1
$a = 0.38$ m s^{-2} A1 [2]

(ii) $F = ma$
$= 42 \times 0.38$ M1
$= 16$ N A0 [1]

(b) *power* = Fv C1
$= 16 \times 1.2$
$= 19$ W A1 [2]

(c) **(i)** component = $42 \times 9.8 \times \sin 2.8$ C1
= 20.1 N A1 [2]

(ii) accelerating force = 20.1 – 16 = 4.1 N C1
acceleration of trolley = 4.1 / 42 = 0.098 m s^{-2} C1
$s = ½at^2$
$3.5 = ½ \times 0.098 \times t^2$ C1
$t = 8.5$ s A1 [4]

(d) *either* allows plenty of time to stop runaway trolley
or speed of trolley increases gradually
or trolley will travel faster B1 [1]
(answer must be unambiguous when read in conjunction with question)

4 **(a** 3.5 T B1 [1

(b) distance = average speed × time (however expressed) C1
= 14 m A1 [2]

(ii) distance = $5.6 \times (T – 5)$ (*or 3.5T – 14*) A [1]

(c) $3.5T = 14 + 5.6(T – 5)$ C1
$T = 6.7$ s A1 [2]

(d) **(i)** acceleration = (5.6 / 5 =) 1.12 m s^{-2} C1
force = ma C1
= 75 N A1 [3]

(ii) power = (force × speed =) {75 + 23} × 4.5 C1
= 440 W A1 [2]
(*allow 1/2 for 234 W, 0/2 for 338 W or 104 W*)

5 **(a)** **(i)** distance from a (fixed) point M1
in a specified direction A1
(Allow 1 mark for 'distance in a given direction')

(ii) (displacement from start is zero if) car at its starting position..... B1 [3]

(b) **(i)1** $v^2 = u^2 + 2as$
$28^2 = 2 \times a \times 450$ (use of component of 450 scores no marks)..... C1
$a = 0.87\ m\ s^{-2}$ ..... A1 [2]
(-1 for 1 sig. fig. but once only in the question)

(i) $v = u + at$ or any appropriate equation
$28 = 0.87t$ or appropriate substitution..... C1
t = 32 s ..... A1 [2]

(i) $E_k = ½mv^2$ C1
$= ½ \times 800 \times 28^2$
$= 3.14 \times 10^5$ J..... A1 [2]

(i) $E_p = mgh$ C1
$= 800 \times 9.8 \times 450 \sin 5$ C1
$= 3.07 \times 10^5$ J ..... A1 [3]

(ii) power = energy/time C1
$=(6.21 \times 10^5)/32.2$ C1
$= 1.93 \times 10^4$ W ..... A1 [3]
(power = Fv with $F = mg \sin\theta$ scores no marks)

(iii) some <u>work also done against friction</u> forces..... M1
location of frictional forces identified ..... A1 [2]
(allow reasonable alternatives)