A-Level Physics

Conservation of Energy

Mark Scheme

Time available: 63 minutes
Marks available: 50 marks

Mark schemes

1. (a) PE = mgh

C1

= 41 × 9.8 × 3.0 =

1200 or 1210 J

A1

2

(b) (i) $mgh = 0.5mv^2$

C1

$v = 7.7\ ms^{-1}$

A1

2

or ecf from (a)

(ii) F = mgcos50

C1

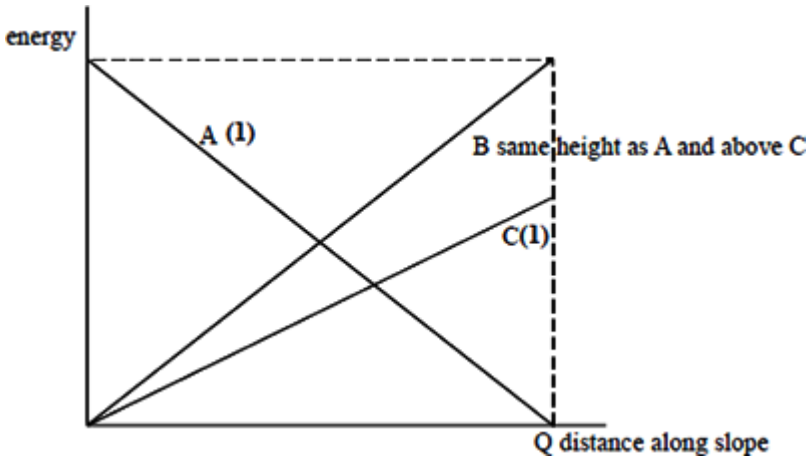
= 258N

A1

2

[6]

2. (a) (i) and (ii)



(iii) A + B = constant **(1)**
loss in potential energy = gain in kinetic energy <u>for A and B</u>
[or potential energy at P = kinetic energy at Q <u>for A and B</u>] **(1)**
reason for C being below B e.g. transfer to heat
[or work done against friction] **(1)**

(6)

(b) (i) clear reference to energy $v_C \left(= \sqrt{2gh}\right) = \sqrt{2 \times 9.8 \times 50}$ **(1)** = 31(.3) m s^{-1} **(1)**

(ii) $F \left(= \frac{mv_c^2}{r}\right) = \frac{80 \times (31.3)^2}{20}$ **(1)**

$= 3.9(2) \times 10^3$ N

towards centre of circle **(1)**

(iii) gain in gravitational potential energy
(= mgh sin θ) = 620 × 9.8 × 60 × sin 20° **(1)**
$= 1.25 \times 10^5$ J

(iv) 620 × 9.8 × 50 = (F × 60) (1) + 1.25×10^5 **(1)**
F = 3000 N **(1)**
alternative (iv)
calculation of acceleration = (–)8.0 m s^{-2} **(1)**
use of $F + mg$ sin $\theta = ma$ **(1)**
F = 3000 N **(1)**

(max 9)

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3. (a) loss of potential energy = m × 9.81 × 6.0 **(1)**
gain in kinetic energy = loss of potential energy **(1)**
½ mv^2 = 58.9 m gives v = 10.8 (m s^{-1}) (≈ 11m s^{-1})

3

(b) loses potential energy (as it moves to B) **(1)**
gains kinetic energy (as it moves to B) **(1)**
regains some potential energy at the expense of kinetic energy as it moves from B to C **(1)**

some energy lost as heat (due to friction) **(1)**

4

The Quality of Written Communication marks are awarded for the quality of answers to this question.

[7]

4.

(a) potential energy to kinetic energy **(1)**
mention of thermal energy and friction **(1)**

2

(b) (use of ½ $mv^2 = mgh$ gives) ½ $v_h^2 = 9.81 \times 1.5$ **(1)**
$v_h = 5.4(2) ms^{-1}$ **(1)**
(assumption) energy converted to thermal energy is negligible **(1)**

3

(c) component of weight down the slope causes acceleration **(1)**
this component decreases as skateboard moves further down the slope **(1)** air resistance/friction increases (with speed) **(1)**

2

(d) (i) distance (= 0.42 × 5.4) = 2.3m **(1)**
(2.27m)
(allow C.E. for value of v_h from (b))

(ii) $v_v = 9.8 \times 0.42$ **(1)**
$= 4.1(l)$ m s^{-1} **(1)**

(iii) $v^2 = 4.1^2 + 5.4^2$ **(1)**
$v = 6.8$ m s^{-1} **(1)**
(6.78 m s^{-1})
(allow C.E. for value of v_h from (b))

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[12]

5.

(a) (i) *($s = ½(u + v)\, t$ $t = 2s/v$* ✓ (correct rearrangement, either symbols or values)

(= 100/6.7) = 15 ✓ (s) (14.925)

or alternative correct approach

2

(ii) ($KE = 1/2mv^2 = ½ \times 83 \times 6.7^2$) = 1900 ✓ (1862.9 J)

2 sf ✓

2

(iii) GPE = 83 × 9.81 × 3.0 ✓ penalise use of 10, allow 9.8

= 2400 (2443 J) ✓ do not allow 2500 (2490) for use of g = 10

2

(b) (i) 5300 + 3700 (or 9000 seen)

or – 2443 – 1863 (or (–) 4306 seen) ✓

= 4700 (J) ✓ (4694) ecf from parts aii & aiii

2

(ii) mention of friction and appropriate location given ✓

mention of **air** resistance (or drag) ✓

do not allow energy losses or friction within the motor

do not allow energy losses from the cyclist

must give a **cause** not just eg 'heat loss in tyres'

2

[10]