GCSE
PHYSICS
AQA - COMBINED SCIENCE
MARK SCHEME

P5
FORCES
TEST 3
Mark schemes

(a) any two from:
• alcohol
• drugs
  *allow named drugs*
• tiredness
• distraction
  *allow named distractions*
  *allow caffeine*
  *allow age*
  *ignore drinking unqualified*

(b) any one from:
• speed of vehicle
• condition of tyres
• condition of brakes
• condition of road surface
• water / ice / snow on road
• braking force
  *allow mass of vehicle*

(c) \( (s =) 13 \times 0.6 \)

\[ = 7.8 \text{ (m)} \]

*an answer of 7.8 (m) scores 2 marks*

(d) 21.8 (m)

*allow ecf from part (c)*

(e) the greater the braking distance

(f) brakes overheat

*allow damage to brakes*

*allow skidding*

*allow damage to car or occupants*
(a) the forces of the bike on the trailer and the trailer on the bike are equal in size

\[ \text{allow the force of tension acts on the bike and the trailer} \]

and opposite in direction

(b) any two from:
- the same trailer should be used
- the weather conditions should be the same
  \[ \text{allow a description of this, eg the wind should be the same} \]
- the same road (surface) should be used
- the same gradient road should be used
- the same speed should be used
- the cyclist should be at the same level of alertness throughout the experiment
  \[ \text{allow a description of a cause of this eg the cyclist should not drink coffee between experiments} \]

(c) straight line drawn above the original line, sloping upwards

(d) the cyclist's reaction time increased

so the thinking distance increased

stopping distance is thinking distance plus braking distance

(a) air resistance

\[ \text{allow drag} \]

\[ \text{ignore wind resistance} \]

(b) B–C

(c) (velocity =) 12.2 (m/s)

\[ \text{(momentum =) } 94.8 \times 12.2 \]

\[ \text{(momentum =) } 1160 \text{ (kg m/s)} \]

\[ \text{allow an answer that rounds to 1160 (kg m/s)} \]

\[ \text{an answer of 1147 / 1150 scores 2 marks} \]

\[ \text{an answer of 1160 (kg m/s) scores 3 marks} \]
(d) tangent drawn at 12 s

correct readings of $\Delta v$ and $\Delta t$ from tangent

\[
\text{(acceleration)} = \frac{\text{their value of } \Delta v}{\text{their value of } \Delta t}
\]

$-2.4 \text{ (m/s}^2\text{)}$

*allow value in range $-2.2$ to $-2.6 \text{ (m/s}^2\text{)}*

*allow a correctly calculated answer from*

\[
\frac{\text{their value of } \Delta v}{\text{their value of } \Delta t}
\]

$m/s^2$

*allow m/s/s*

(e) straight line (with gradient of 1.6) from origin to 6 s, 9.6 m/s

*allow 1 mark for a straight line below A−B with a positive gradient from origin to 6 s*

(f) (calculation of distance travelled by first athlete)

\[(2.2 \times 12.2) = 26.84 \text{ (m)}\]

\[(0.5 \times 3.8 \times 12.2) = 23.18 \text{ (m)}\]

*an answer of 50.02 (m) scores 2 marks*

(calculation of distance travelled by second athlete)

\[(0.5 \times 9.6 \times 6 =) 28.8 \text{ (m)}\]

*allow ecf from part (e)*

*allow (9.6^2 - 0 = 2 \times 1.6 \times s =) 28.8 (m)*

(calculate difference) = 21.22 (m)

*allow their distance for athlete 1 minus their distance for athlete 2*

*an answer of 21.22 (m) scores 4 marks*
(a) between A and B (the elastic store decreases and) the kinetic and gravitational stores increase

between B and C the kinetic store decreases and the gravitational store increases

the internal energy store of the surroundings increases

allow either

some energy is dissipated to the surroundings

or

some energy is dissipated as heat / sound

(b) the weight and air resistance are equal and opposite

so the resultant force is zero

(c) \[ 25000 = \frac{1}{2} \times 125 \times e^2 \]

\[ e^2 = \frac{2 \times 25000}{125} \]

\[ e = \sqrt{\frac{2 \times 25000}{125}} \]

\[ e = 20 \text{ (m)} \]

an answer of 20 (m) scores 4 marks

(d) acceleration = (–)9.8\(\text{(m/s}^2\)\)

\[ 0^2 - 26^2 = 2 \times (-9.8) \times s \]

\[ s = \frac{-26^2}{2 \times (-9.8)} \]

\[ s = 34 \text{ (m)} \]

allow any correct rounding of 34.489...

an answer of 34 (m) scores 4 marks
(a) scalars have magnitude only
   \[ \text{allow size for magnitude} \]

   vectors have magnitude and direction

(b) any \textbf{three} from:

   • arrow pointing vertically downwards originating in the block, labelled weight
     \[ \text{allow gravity} \]

   • arrow pointing left along the surface labelled friction; part of the arrow must be
     between the block and the carpet

   • arrow pointing to the left touching block labelled air resistance or drag

   • arrow pointing vertically upwards from bottom surface of block, labelled
     (normal) contact force
     \[ \text{allow reaction (force) for contact (force)} \]
     \[ \text{judge horizontal and vertical by eye} \]
     \[ \text{allow 1 mark for three correctly labelled arrows, in} \]
     \[ \text{correct directions but in incorrect positions} \]

(c) clear attempt to draw horizontal and vertical components

   \[ \text{horizontal line should extend beyond dashed line on diagram} \]

   horizontal component: 2.6 (N)
   \[ \text{allow a range from 2.5 to 2.7} \]

   vertical component: 1.7 (N)
   \[ \text{allow a range from 1.6 to 1.8} \]

   \[ \text{if 2nd and 3rd marking points not awarded, allow 1 mark} \]
   \[ \text{for clear measurements of both 5.2 \pm 0.2 \text{ cm and 3.4 \pm 0.2 \text{ cm}}} \]

(d) \[ \frac{5.2 + X + 5.3}{3} = 5.4 \]

   \[ (X =) 5.7 \text{ (N)} \]
   \[ \text{allow 5.6 (N) or 5.8 (N) for 2 marks} \]
   \[ \text{an answer of 5.7 (N) scores 2 marks} \]
(e) any three from:
  • angle (of string)
  • speed (at which block is pulled)
    
    *allow velocity (at which block is pulled)*
  • area of block in contact with surface
  • mass / weight of block
    
    *ignore same block*

(a) inertia

(b) \(17 \text{ cm/s} = 0.17\text{m/s}\)

\[
P = mv = 0.14 \times 0.17
\]

\[= 0.024 \text{ (kg m/s)}
\]

*an answer of 0.024 (kg m/s) scores 3 marks*

(c) the total momentum before the collision is zero

and momentum is conserved

so the total momentum after the collision is zero

so the speed after the collision is zero

(d) more than one car may pass through a beam at a time

*allow a description of this eg cars overtaking, cars passing in opposite directions etc*

(so) the light gate could not accurately measure the time for one car to pass

the length of each car would be unknown

*allow cars come in different lengths.*

(so) speed could not be calculated without the length

*ignore references to the data logger*

(a) mass
velocity

(b) kg m / s

(c) momentum before = momentum after

and before diving in the momentum of the diver and (small) boat is zero

after diving the diver has forwards momentum / momentum to the right

therefore the (small) boat has equal backwards momentum / equal momentum to the left

(d) the boat moves back more slowly

because there is more mass (but momentum stays the same)

(e) as she swims there is a drag force

as speed increases so does the drag force

she accelerates less

drag force = thrust force

\[ \text{accept resultant force} = 0 \]

the swimmer reaches terminal velocity

(a) \[ a = \frac{12}{20} \]

= 0.6

m/s²

*an answer of 0.6 scores 2 marks*

*if first 2 marks not awarded, allow 1 mark for an attempt to determine \( a = \frac{\Delta v}{t} \) with incorrect values from graph*

*allow ms⁻²*
(b) (first calculate area under graph) 20s: $0.5 \times 20 \times 12 = 120$ (m)

next 25s: $25 \times 12 = 300$ (m)

final 6s: $0.5 \times 6 \times 12 = 36$ (m)

total: $120 + 300 + 36 = 456$ (m)

an answer of 456 (m) scores 4 marks

(c) $258 = \frac{1}{2} 45300 \times e^2$

$$e = \sqrt{\frac{2 \times 258}{45300}}$$

= 0.107 (m)

an answer of 0.107 (m) scores 3 marks

allow 0.11, 0.106727...

(d) stopping distances lower on asphalt than concrete (for all tread depths)

as tread depth increases, stopping distance decreases

below a certain tread depth, stopping distance increases much faster

if values quoted, expect to see

4 mm for asphalt and 2.5 mm for concrete

(e) stopping distance also includes thinking distance

allow stopping distance = thinking distance + braking distance

braking distance can never be zero

[15]