Mark schemes

1.

(a)

*an answer of 7 (s) gains **2** marks*

(4 − 0) + (10 − 7)
or 4 + 3
or 10 − 3

1

7 (s)

1

(b)

*an answer of 0.2 (m/s^2) gains **2** marks*

$\text{gradient} = \frac{0-2}{24-14}$

allow readings from any two points correctly substituted

1

(−) 0.2 (m/s^2)

allow correct use of $a = \frac{\Delta v}{t}$

1

(c) (there are no wires) to get tangled / disconnected

allow easier to move arms
allow wires are inconvenient
allow easier to transfer data

1

(d) wave speed = frequency × wavelength

allow $v = f\lambda$
allow any correct re-arrangement

1

(e)

*an answer of 0.125 (m) or 0.13 (m) scores **3** marks*

300 000 000 = 2 400 000 000 × λ

1

$\lambda = \frac{300\,000\,000}{2\,400\,000\,000}$

1

λ = 0.125 (m)

allow $\lambda = 0.13$ *(m)*

1

(f) range is far enough (for most uses)

1

power is not too great so the battery will not drain quickly

allow power not too great so the phone will not overheat

allow the range per milliwatt is greatest or 4 metres

1

[11]

2. (a) **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

3–4

Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- if two quantities have been determined, $v = f \lambda$ can be used to find the third.

Frequency

- use a stopclock
- count the number of waves passing a point in a fixed time period
- divide the time by the number of waves to determine the time for one wave, T
- $f = 1/T$
- read the frequency off the oscillator

Wavelength

- use a camera to freeze the image
- use a metre rule to measure the distance between two wavefronts
- count the number of waves between the wavefronts
- divide distance by the number of waves to determine λ

Velocity

- determine a mean value of frequency
- determine a mean value of wavelength
- measure the time it takes one wavefront to travel the length of the screen
- measure the length of the screen
- speed = distance / time

To access Level 3 there must be a description of how frequency, wavelength and velocity can be determined

(b) (the duck) moves perpendicular to the direction of wave travel

duck moves up and down is insufficient

1

(c) mean maximum height = 511

and

mean minimum height = 500

1

511 − 500 = 11

allow a calculated difference from incorrect means

1

11 / 2 = 5.5 (mm)

allow their difference divided by 2

any correct method of determining the mean amplitude can score 3 marks

1

*an answer of 5.5 (mm) gains **3** marks*

[10]

3. (a) distance

1

speed

1

(b) (both have magnitude) only a vector has direction

allow scalar does not have a direction

1

(c) any **two** from:

- mass
  allow weight
- velocity
  allow speed or direction
- friction
  allow air resistance or drag
- power of the motor

2

(d) total momentum is zero after the collision (because the bumper cars are stationary)

1

because the momentum of each car before the collision was equal (in magnitude) and opposite (in direction)

1

so the total momentum of the bumper cars was zero before the collision

1

and momentum is conserved

OR

total momentum is zero after the collision (because the bumper cars are stationary) (1)

because the momentum of each car before the collision was equal (in magnitude) and opposite (in direction) (1)

both cars exert an equal and opposite force on each other (for equal periods of time) (1)

so the cars accelerate (in opposite directions) (1)

[9]

4. (a)

1

(b) reverse the direction of the current

1

reverse the direction of the magnetic field

1

(c)

*an answer of 4.0 (A) scores **4** marks*

B = 0.360 (T)

1

0.072 = 0.360 × I × 0.050

allow a correct substitution using an incorrectly / not converted value of B

1

$$I = \frac{0.072}{(0.360 \times 0.050)}$$

allow a correct rearrangement using an incorrectly / not converted value of B

1

I = 4.0 (A)

allow a correct calculation using an incorrectly / not converted value of B

1

(d) there is a magnetic field (due to the permanent magnet) **and** current in a wire causes a magnetic field

1

current is in opposite directions in each side of the coil

1

so forces act in opposite directions on either side of the coil

1

(the split ring ensures that) the current in the left / right side of the coil is always in the same direction

allow (the split ring ensures that) the force in the left / right side of the coil is always in the same direction

allow the current reverses each half rotation

1

[11]

5. (a) radio (waves)

1

(b) 2.5 km = 2500 m

1

300 000 000 = f × 2500

this mark may score if λ is not/incorrectly converted

1

$f = \frac{300\,000\,000}{2500}$

this mark may score if λ is not/incorrectly converted

1

f = 120 000 (Hz)

or

$f = 1.2 \times 10^5$ (Hz)

allow an answer consistent with their value of λ

1

(c) **Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

3–4

Level 1: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

1–2

No relevant content.

0

Indicative content

Measurements

- take reading of temperature using infrared detector (and record)
- repeat with each cube

Control variables

- cubes same volume
- cubes made of same metal
- add same volume of (hot) water
- add water at same temperature
- distance of detector from surface
- air temperature
- thickness / type of paint
- leave for same amount of time **or** record every minute

Methods with only measurements or only control variables are limited to Level 1

(d) black

1

(e) (people with measles / infections) have raised temperature

allow people with measles / infections have fever

1

(so) emit infrared (radiation) at a greater rate

ignore emit more infrared (radiation) unqualified

1

[12]

6. (a) thrust decreases

allow air resistance or drag increases

ignore air resistance decreases as speed decreases

1

so there is a resultant force in opposite direction

allow so air resistance or drag is greater than thrust

1

lift must decrease (because weight stays the same)

1

so there is a resultant downwards force

allow so weight is greater than lift

the last two marking points cannot be awarded if there is a reference to the weight increasing

1

(b)

*an answer of 300 000 (kg) scores **5** marks*

$a = \frac{(10-80)}{28}$

allow $a = \frac{(80-10)}{28}$

1

$a = (-)2.5\ (m/s^2)$

a valid equation must have been used to calculate a to score subsequent marks

1

$(-)\ 750\ 000 = m \times (-)2.5$

allow a correct substitution using their calculated value of a

1

$m = \frac{(-)750\ 000}{(-)2.5}$

allow a correct rearrangement using their calculated value of a

1

$m = 300\ 000$ (kg)

allow a correct calculation using their calculated value of a

1

[9]

7. (a) speed / velocity in the glass is lower

speed / velocity changes is insufficient

allow the refractive index of glass is higher than that of air

allow glass has a higher optical density than air

1

so the edge of the wave(front) entering the glass slows down

1

but the part of the wave(front) in the air continues at the higher speed / velocity (causing a change in direction)

1

(b) correct ray in the prism bent towards the normal

1

second normal at 90° at the point the ray emerges

1

correct emergent ray bent away from the normal

this mark can be awarded without a normal line drawn

1

(c) violet has the shortest wavelength (400 nm)

1

violet light travels the slowest in water

1

violet light undergoes the greatest change in speed (and direction)

1

[9]