Energy H

https://IIQOHIB.exampro.net

Q1.

The image shows a girl riding a self-balancing scooter.

(a) The scooter has an electric motor powered by a battery.

During the ride the battery transfers 15 000 C of charge.

The potential difference across the battery is 36 V

Calculate the energy transferred by the battery.

Use the equation:

energy transferred = charge flow × potential difference

Give your answer in kJ

Energy transferred = _____ kJ

(3)

The table gives data for two scooters with different motors.

Both motors have the same efficiency.

	Power of motor in W	Mass in kg
Scooter A	500	10.5
Scooter B	700	14.0

(b) Explain why scooter **B** has a higher maximum speed.

(2)

(c) Both scooters can be ridden for 20 minutes before the battery needs recharging.

Compare the amount of chemical energy stored in the batteries of each scooter.

(1)

(d) Write the equation that links energy transferred, power and time.

(1)

(e) Calculate the energy transferred by the motor in scooter **B** in 20 minutes.

Energy transferred = _____ J

(3)

(Total 10 marks)

Q2.

A student investigated the specific heat capacity of metals.

(a) Describe an experiment the student could do to measure the specific heat capacity

of a metal.

(6)

(b) The student calculated the specific heat capacity of four metals.

The table below shows the student's results.

Metal	Mass of material in kg	Time in minutes	Temperature in °C	Change in thermal energy in J	Calculated specific heat capacity of material in J / kg °C
Aluminium	1	10	2	4 780	2 390
Brass	1	10	4	4 660	1 165
Copper	1	10		4 600	657
Steel	1	10	5	4 690	938

Use data from the table above to calculate the temperature change for copper.

Use the correct equation from the Physics Equation Sheet.

Temperature change = _____ °C

(3)

(c) What is the independent variable in the student's investigation?

Tick **one** box.

Mass of material ☐

Power used ☐

Time in minutes ☐

Type of material ☐

(1)

(d) The student calculated the specific heat capacity of aluminium to be 2390 J / kg °C.

The 'true' specific heat capacity of aluminium is 900 J / kg °C.

Suggest why the student's result for aluminium is different from the 'true' value.

_____

_____

_____

_____

(2)

(e) The teacher suggested that putting bubble wrap round the metal block would change the results.

How would using bubble wrap change the results?

Give a reason for your answer.

_____

_____

_____

_____

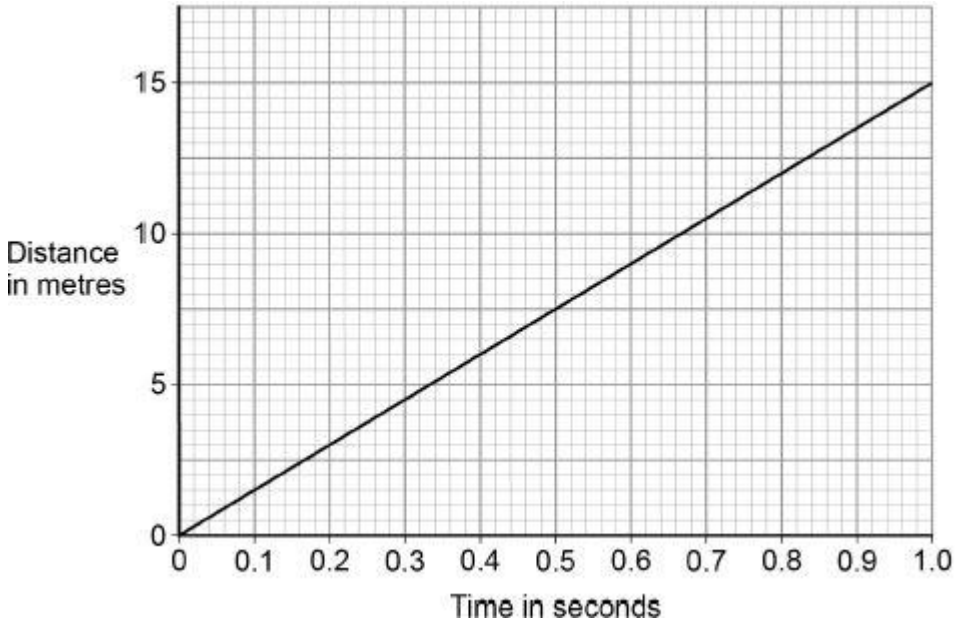
(2)

(Total 14 marks)

Q3.

(a) **Figure 1** shows the distance-time graph for a car travelling at 15 m/s

Figure 1



When the driver is tired, his reaction time increases from 0.50 seconds to 0.82 seconds.

Determine the **extra** distance the car would travel before the driver starts braking.

Distance = _____ m

(2)

(b) When the brakes are used, the temperature of the brakes increases.

Explain why. Use ideas about energy in your explanation.

(2)

(c) A lorry travels 84 m with a constant acceleration of 2.0 m/s^2 to reach a velocity of 19 m/s

Calculate the initial velocity of the lorry.

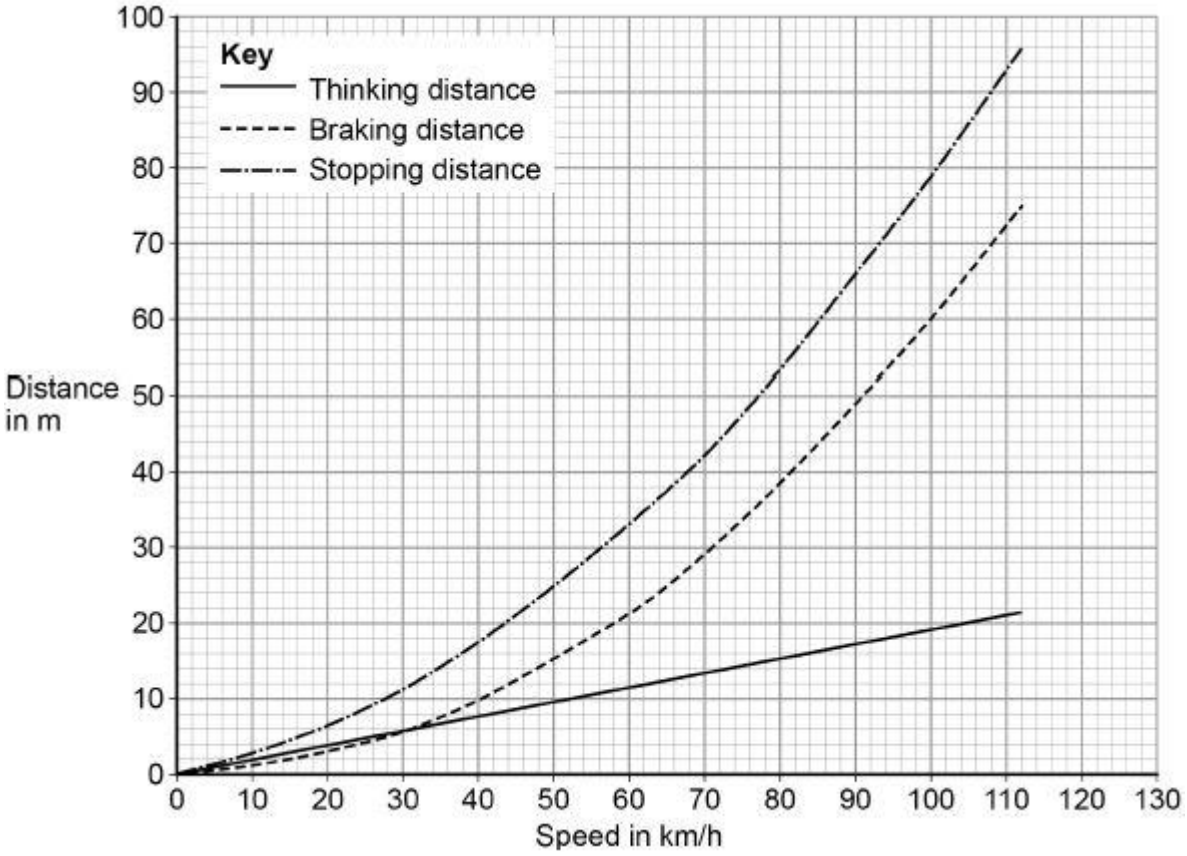
Use the Physics Equations Sheet.

Initial velocity = _____ m/s

(3)

(d) **Figure 2** shows how the thinking distance, braking distance and stopping distance for a car vary with the speed of the car.

Figure 2



Describe the relationships shown in **Figure 2**

You should include factors that would affect the gradient of the lines.

_____

_____

_____

_____

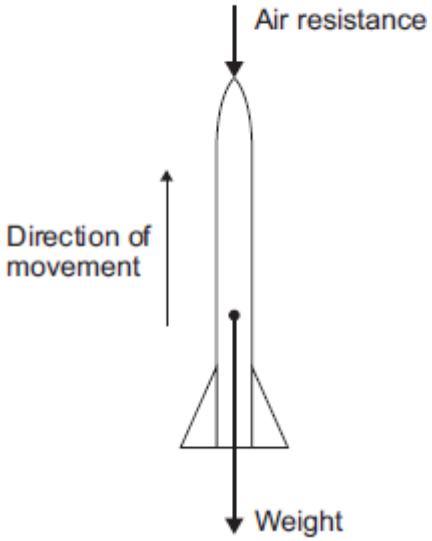
(6)

(Total 13 marks)

Q4.

(a) **Figure 1** shows the forces acting on a model air-powered rocket just after it has been launched vertically upwards.

Figure 1



(i) How does the velocity of the rocket change as the rocket moves **upwards**?

_____

Give a reason for your answer.

_____

_____

(2)

(ii) The velocity of the rocket is not the same as the speed of the rocket.

What is the difference between the velocity of an object and the speed of an object?

_____

_____

_____

(1)

(b) The speed of the rocket just after being launched is 12 m / s.
The mass of the rocket is 0.05 kg.

(i) Calculate the kinetic energy of the rocket just after being launched.

_____

_____

_____

Kinetic energy = _____ J

(2)

(ii) As the rocket moves upwards, it gains gravitational potential energy.

State the maximum gravitational potential energy gained by the rocket.

Ignore the effect of air resistance.

Maximum gravitational potential energy = _____ J

(1)

(iii) Calculate the maximum height the rocket will reach.

Ignore the effect of air resistance.

Gravitational field strength = 10 N/kg.

_____

_____

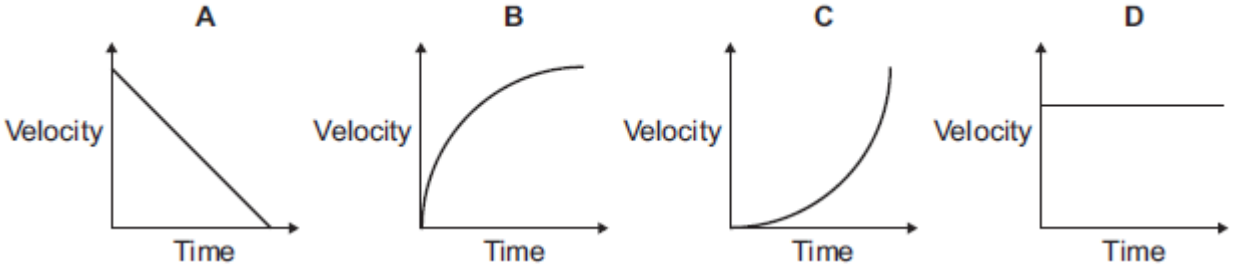
_____

Maximum height = _____ m

(2)

(iv) **Figure 2** shows four velocity−time graphs.

Figure 2



Taking air resistance into account, which graph, **A**, **B**, **C** or **D**, shows how the velocity of the rocket changes as it **falls** from the maximum height it reached until it just hits the ground?

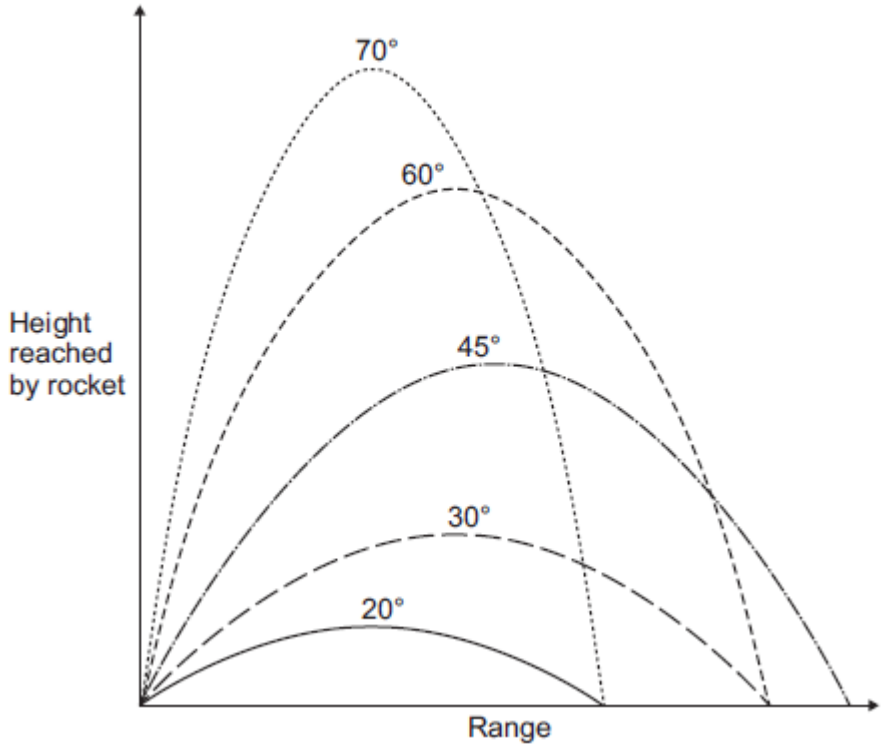
Write the correct answer in the box. ☐

(1)

(c) The rocket can be launched at different angles to the horizontal.
The horizontal distance the rocket travels is called the range.

Figure 3 shows the paths taken by the rocket when launched at different angles.
Air resistance has been ignored.

Figure 3



What pattern links the angle at which the rocket is launched and the range of the rocket?

_____

_____

_____

_____

(2)

(Total 11 marks)

Q1.

(a) E = 15 000 × 36

1

E = 540 000

1

E = 540 (kJ)

*an answer of 540 (kJ) scores **3** marks*

1

(b) (the motor in) scooter **B** has a higher power

1

therefore

(because both motors have the same efficiency) scooter **B** will have a greater kinetic energy

1

(c) the battery in scooter **B** has a greater store of chemical energy

1

(d) energy transferred = power × time

allow $E = P \times t$

1

(e) 20 × 60

1

E = 1 200 × 700

1

E = 840 000 (J)

*an answer of 840 000 (J) scores **3** marks*

1

[10]

Q2.

(a) **Level 3 (5–6 marks):**
A full, detailed and coherent plan covering all the major steps is provided, which outlines what needs to be measured to calculate specific heat capacity. The steps are set out
in a logical manner that could be followed by another person to calculate the specific heat capacity.

Level 2 (3–4 marks):
The substantive content of a plan is present but may be missing some steps. The plan
may not be in a completely logical sequence but leads towards the calculation of the specific heat capacity.

Level 1 (1–2 marks):

Simple statements relating to relevant apparatus or steps are made but they may not be
in a logical order. The plan would not allow another person to calculate specific heat capacity.

0 marks:
No relevant content.

Indicative content

- measure the mass of metal
- correct use of balance
- description of how work is done or energy transferred to metal
  eg electrical work, mechanical work (eg dropping lead shot)
- how energy transfer or work done is measured
  eg electrical using joulemeter, mechanical decrease in potential energy store of falling lead shot
- equate work done / energy transferred = increase in thermal energy store of the
  metal
- calculate specific heat capacity

6

(b) 4 600 = 1 × 657 × temperature change

1

temperature change = 4 600 / 657

1

= 7 (°C)

*allow 7 with no working shown for **3** marks*

1

(c) Type of material

1

(d) heat loss

1

then any **one** from:

- turned off the power supply too early
- incorrectly measured mass of material
- incorrectly measured temperature
- incorrectly read the change in thermal energy

1

(e) would give a more accurate value **or** the calculated specific heat capacity will be smaller

1

because the bubble wrap insulates the material **or** prevents heat loss

1

[14]

Q3.

(a) either:
7.5 (m) **and** 12.3 (m) from the graph

or

15 (m/s) × 0.32 (s) using speed

allow 7.5 (m) and between 12.2 (m) and 12.4 (m)

1

extra distance = 4.8 (m)

1

*an answer between 4.7 (m) and 4.9 (m) scores **2** marks*

(b) there is a decrease in kinetic energy of the car

allow work is done by friction (on the brakes)

1

so this (causes) the internal / thermal energy store of the brakes to increase

1

(c) $19^2 - u^2 = 2 \times 2 \times 84$

1

$u^2 = 19^2 - (2 \times 2 \times 84)$

1

u = 5 (m/s)

$$u = \sqrt{19^2 - (2 \times 2 \times 84)}$$

1

an answer of 5 (m/s) scores 3 marks

(d) **Level 3:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.

5–6

Level 2: Scientifically relevant facts, events or processes are identified and their relevance is clear. The account is not fully accurate.

3–4

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.

1–2

No relevant content

0

Indicative content

- use of drugs, alcohol, tiredness and distractions would increase the thinking distance
- thinking distance increases with speed
- thinking distance is directly proportional to speed
- use of drugs, alcohol, tiredness and distractions would increase the gradient of thinking distance

- poor brakes, poor tyres, wet / icy roads and mass would increase the braking distance
- braking distance increases with speed
- braking distance increases at an increasing (accept greater) rate (with speed)
- poor brakes, poor tyres, wet / icy roads and mass would increase the

gradient of braking distance

- braking distance is directly proportional to speed squared

- stopping distance = thinking distance + braking distance
- factors that increase thinking and / or braking distance would increase the gradient of stopping distance
- stopping distance increases at an increasing (accept greater) rate (with speed)

[13]

Q4.

(a) (i) decreases (to zero)

1

resultant force acts in opposite direction to motion

accept air resistance and weight for resultant force

accept resultant force acts downwards

*do **not** accept air resistance increases*

1

(ii) velocity includes direction

or

velocity is a vector (quantity)

1

(b) (i) 3.6

allow 1 mark for correct substitution i.e.

½ × 0.05 × 12^2 provided no subsequent step

2

(ii) 3.6 **or** their (i)

1

(iii) 7.2

or

their (ii) ÷ 0.5 correctly calculated

*allow **1** mark for correct substitution i.e.*

3.6 or their (ii) = 0.05 × 10 × h

2

(iv) **B**

1

(c) range increases up to 45°

1

range decreases from 45°

the range is a maximum at 45° gains both marks

for any two angles that add up

to 90° the range is the same gains both marks

*the range increases then decreases gains **1** mark*

1

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