K11E Forces and Motion: Depth and Practice

AQA AQA KS3 Physics · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name the force that pulls objects toward the centre of the Earth.

(1)

2 A cyclist is moving at steady speed along a straight road. State two forces acting on the cyclist and say whether each is a contact or a non-contact force.

(3)

3 A small trolley has mass 0.80 kg. It is pulled with a horizontal force of 3.2 N across a table at constant speed. Calculate the frictional force between the trolley and the table.

(4)

4 Give the equation linking weight, mass and gravitational field strength. Then calculate the weight of a 9 kg suitcase using g = 10 N/kg.

(2)

5 Priya pushes a toy car from rest. The car accelerates and reaches a speed of 2.0 m/s in 4.0 s. Calculate the acceleration of the car and state its unit.

(4)

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6 Explain what is meant by the resultant force acting on an object.

(3)

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7 Kwame drops a ball and measures its motion. He records that during a short fall the ball reaches a terminal speed when air resistance equals the weight. Describe, in terms of forces and resultant force, why the ball stops accelerating when it reaches terminal speed.

(4)

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8 Name the force that slows a moving car through the air.

(1)

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9 A driver brakes and reduces the car's speed from 20 m/s to 10 m/s in 5 s. Calculate the average acceleration (or deceleration).

(2)

10 A student investigates the stopping distance of a toy car when different surfaces are used. The student uses the same car released from the same starting point and measures stopping distance on a smooth tile surface and on a rough carpet. Suggest two variables the student must control to make the test fair and explain why for each.

(4)

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11 A toy car travels 1.8 m in 0.9 s. Calculate its average speed in m/s.

(3)

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12 A student draws two arrows on a diagram to show forces on a hanging sign: one arrow down labelled 30 N and one arrow up. If the sign is at rest and the upward force is 30 N, what is the resultant force on the sign? State the magnitude and direction.

(2)

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13 An object has two horizontal forces on it: 10 N to the right and 6 N to the left. Calculate the resultant force and state the direction.

(2)

14 Describe how increasing the mass of an object affects its acceleration when the same force is applied. Use Newtons second law idea in your answer.

(3)

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15 Extended response: A class is asked to investigate how the length of a slope affects the speed of a toy car at the bottom. They use the same car, the same slope angle, and three different slope lengths. Describe a fair method the class could use, identify the key variables, predict the expected trend and explain the scientific reason using forces and energy ideas. Finally, suggest two improvements to make the investigation more reliable.

(6)

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16 A car of mass 800 kg accelerates at 2.5 m/s^2. Calculate the resultant force acting on the car.

(3)

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17 A 0.5 kg object is pushed along level ground with two horizontal forces: 3 N to the right and 1 N to the left. Calculate the acceleration of the object and give its direction.

(4)

18 A parachutist of mass 75 kg reaches a steady speed when falling. If the weight of the parachutist is 750 N, what upward force from air resistance acts on the parachutist at steady speed? Explain your answer briefly.

(3)

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19 A student measures the time taken for a toy car to travel 0.40 m when pushed with two different forces. With force A the time is 0.80 s; with force B the time is 0.57 s. Calculate the average speed in each case and say which force produced the greater speed. Show your working.

(4)

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20 A student draws a free-body diagram for a book resting on a slope showing a single arrow down the slope labelled 12 N and a single arrow up the slope labelled 8 N. What is the resultant force along the slope and which way will the book move? (2 marks)

(2)

Mark scheme · K11E Forces and Motion: Depth and Practice

Question 1

- **B1** gravity (weight as name of the force) cao
- Answer: **Gravity (weight as the force of gravity).**

Question 2

- **B1** friction or air resistance - contact
- **B1** normal contact force from the road on the tyres - contact
- **B1** gravity (weight) - non-contact
- Answer: **Examples: friction or air resistance - contact; normal contact force from road - contact; gravity (weight) - non-contact.**

Question 3

- **M1** use idea constant speed means resultant horizontal force = 0 so friction = pulling force
- **A1** 3.2 N cao
- **B1** statement that friction acts in opposite direction to motion
- **A1** calculation shown or restatement 3.2 N cao
- Answer: **3.2 N**

Question 4

- **M1** weight = mass x gravitational field strength or W = m g
- **A1** 90 N cao
- Answer: **W = m g; 90 N**

Question 5

- **M1** use a = change in speed / time = (2.0 - 0) / 4.0
- **A1** 0.50 m/s^2 cao with unit
- **B1** unit stated as m/s^2
- **A1** calculation shown 2.0 / 4.0 = 0.5 cao
- Answer: **0.50 m/s^2**

Question 6

- **M1** statement that resultant force is the single force that has the same effect as all the forces acting combined
- **A1** idea that if resultant is zero forces are balanced and motion does not change
- **B1** idea that non-zero resultant changes speed or direction (cause acceleration) oe
- Answer: **The resultant force is the single force that represents the combined effect of all forces; if it is zero forces are balanced and motion does not change, if not zero the object accelerates or changes direction.**

Question 7

- **M1** air resistance increases with speed until it equals weight
- **M1** when air resistance = weight the upward and downward forces are equal
- **A1** resultant force is zero so acceleration stops and speed is constant (terminal speed)
- **A1** statement that before equality the resultant was downwards causing acceleration, oe
- Answer: **Air resistance increases as the ball speeds up until it equals the weight; at that point upward and downward forces balance so resultant force is zero and acceleration stops, giving a constant terminal speed.**

Question 8

- **B1** air resistance (drag) cao
- Answer: **Air resistance (drag).**

Question 9

- **M1** use a = (v - u) / t = (10 - 20) / 5
- **A1** -2 m/s^2 cao
- Answer: **-2 m/s^2**

Question 10

- **M1** control starting height or release method to ensure same initial potential energy or speed
- **M1** use the same car and wheels to keep mass and wheel condition constant
- **A1** explain that different starting heights or speeds change stopping distance so must be same
- **A1** explain that different car mass or wheel condition would change friction and stopping distance
- Answer: **Control the starting height/release method and use the same car and wheels so starting speed and mass/wheel condition do not change; this keeps the test fair.**

Question 11

- **M1** use speed = distance / time = 1.8 / 0.9
- **A1** 2.0 m/s cao
- **B1** unit stated as m/s
- Answer: **2.0 m/s**

Question 12

- **B1** 0 N
- **B1** direction none or balanced forces gives no resultant
- Answer: **0 N, there is no resultant (forces are balanced).**

Question 13

- **M1** calculate resultant = 10 - 6 = 4
- **A1** 4 N to the right cao
- Answer: **4 N to the right**

Question 14

- **M1** state F = m a idea or that acceleration depends on force and mass
- **M1** explain that with same force larger mass gives smaller acceleration
- **A1** give an example phrase or consequence, e.g. doubling mass halves acceleration, oe
- Answer: **Using F = m a, if the applied force stays the same then a = F/m, so increasing mass reduces acceleration; for example doubling mass halves acceleration.**

Question 15

- **Level 1** (1-2): Basic method and limited physics. Simple suggestion of variables and a vague prediction. Limited or no improvements suggested.
- **Level 2** (3-4): Clear method with control of key variables, correct prediction and some scientific explanation using forces or energy. At least one reasonable improvement.
- **Level 3** (5-6): Detailed, repeatable method controlling variables, accurate prediction and clear explanation using both forces and conservation of energy. Two realistic improvements that would increase reliability or reduce random and systematic error.
- **Indicative content:**
  - Method: set up slope at fixed angle, measure three slope lengths, release car from top with identical release mechanism, measure speed at bottom using light gate or measure time over set distance and calculate speed.
  - Variables: independent = slope length; dependent = speed at bottom; control = slope angle, car mass, wheel condition, release method, surface.
  - Prediction: longer slope gives larger speed at bottom (up to a point) because more gravitational potential energy is converted to kinetic energy, ignoring larger energy losses to friction/air resistance.
  - Explanation: gravitational force along slope does work; energy lost to friction increases with distance so trend may show diminishing returns; using F = m a and energy ideas gives consistent explanation.
  - Improvements: repeat each length several times and take mean; use a light gate to measure speed accurately; ensure slope surface and car wheels are clean to reduce variability.

Question 16

- **M1** use F = m a substitution F = 800 x 2.5
- **A1** 2000 N cao
- **B1** unit stated as N or shown in answer
- Answer: **2000 N**

Question 17

- **M1** calculate resultant force = 3 - 1 = 2 N to the right
- **M1** use a = F / m substitution a = 2 / 0.5
- **A1** 4 m/s^2 cao
- **A1** direction to the right
- Answer: **4 m/s^2 to the right**

Question 18

- **M1** state at steady speed upward force equals weight
- **A1** 750 N cao
- **B1** brief explanation that resultant is zero so speed is constant
- Answer: **750 N; because at steady speed the upward air resistance balances the weight giving a resultant force of 0 N.**

Question 19

- **M1** calculate speed A = 0.40 / 0.80 = 0.5 m/s
- **A1** 0.50 m/s cao
- **M1** calculate speed B = 0.40 / 0.57 = 0.70175... -> 0.70 m/s
- **A1** 0.70 m/s cao and statement that force B produced the greater speed
- Answer: **Speed A = 0.50 m/s; Speed B = 0.70 m/s. Force B produced the greater speed.**

Question 20

- **M1** calculate resultant = 12 - 8 = 4 N
- **A1** 4 N down the slope cao
- Answer: **4 N down the slope**