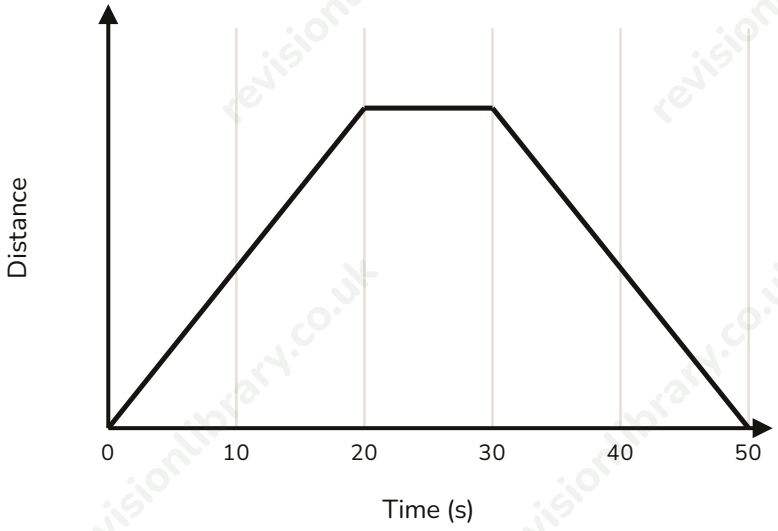
3.1 Forces and Motion: 30-minute Pack

Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A runner's distance-time graph shows the following: a straight line sloping upward from 0 to 20 s, then a flat (horizontal) section from 20 s to 30 s, then a straight line sloping downward back to zero distance from 30 s to 50 s.



(a) Describe what is happening to the runner between 0 and 20 s. **(1)**

(b) Describe what is happening to the runner between 20 and 30 s. **(1)**

(c) Describe what is happening to the runner between 30 and 50 s. **(1)**

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2 A submarine has ballast tanks that can be filled with seawater, or emptied by pumping in compressed air, changing the submarine's weight without changing the upthrust of the water pushing up on it.

(a) Name the two forces that act on a submarine when it is staying still at a constant depth underwater. **(2)**

(b) State the relationship between the sizes of these two forces when the submarine is staying at a constant depth. **(1)**

(c) Explain, in terms of these forces, how filling the ballast tanks with more seawater causes the submarine to sink. **(2)**

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3 Equation you may need: resultant force = mass x acceleration (F = m a). An ice hockey puck has a mass of 0.17 kg. A player's stick exerts a resultant force of 34 N on the puck during a shot. Calculate the puck's acceleration during the shot.

(3)

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4 Practical investigation: a student investigates how the extension of a length of catapult elastic depends on the force applied. She measures its natural length, then hangs increasing loads from it and measures the new length each time. Her results are shown in the table.

Force (N)	Extension (mm)
0	0
2	15
4	30
6	45
8	60
10	90

(a) Describe the pattern shown by the results between 0 N and 6 N. **(1)**

(b) State the force at which the elastic stops extending proportionally with the force applied (the limit of proportionality). **(1)**

(c) Equation you may need: elastic constant k = force / extension (k = F / e). Use the result at 4 N to calculate the elastic constant of the catapult elastic. Give your answer in N/mm. **(2)**

(d) The student wants to predict the extension the elastic would give with a 20 N force. Explain why she should not use her elastic constant from part (c) to make this prediction. **(1)**

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5 For each statement, identify whether it is True or False. If a statement is false, give the correct version.

(a) If the forces acting on a stationary object are balanced, the object will remain at rest. **(1)**

(b) A non-contact force can only act between two magnetic objects. **(1)**

(c) For an object of fixed mass, a bigger resultant force gives a greater acceleration. **(1)**

(d) Moment is measured in newtons (N). **(1)**

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6 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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7 A toy car travels 1.8 m in 0.9 s. Calculate its average speed in m/s.

(3)

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Mark scheme · 3.1 Forces and Motion: 30-minute Pack

Question 1

(a) moving away from the start at a constant/steady speed, oe — **B1**

(a) Answer: **Moving away from the start at a constant speed.**

(b) stationary/resting (not moving), oe — **B1**

(b) Answer: **Stationary (resting), since the distance does not change.**

(c) moving back toward the start at a constant/steady speed, oe — **B1**

(c) Answer: **Moving back toward the start at a constant speed.**

Question 2

(a) weight — **B1**

(a) upthrust (the upward force from the water) — **B1**

(a) Answer: **Weight and upthrust.**

(b) they are equal in size (balanced), oe — **B1**

(b) Answer: **They are equal in size (balanced forces).**

(c) filling the tanks with more seawater increases the submarine's total weight — **M1**

(c) weight becomes greater than upthrust, giving a resultant (unbalanced) force downward, so the submarine sinks, oe — **A1**

(c) Answer: **Filling the tanks with more seawater increases the submarine's weight so it becomes greater than upthrust, giving an unbalanced downward force that makes it sink.**

Question 3

correct rearrangement a = F / m — **M1**

correct substitution a = 34 / 0.17 — **A1**

200 m/s^2 cao — **A1**

Answer: **200 m/s^2**

Question 4

(a) extension is directly proportional to force between 0 N and 6 N (a straight line through the origin; extension increases by 15 mm for every extra 2 N), oe — **B1**

(a) Answer: **Extension is directly proportional to the force applied between 0 N and 6 N.**

(b) 8 N (accept between 8 N and 10 N) cao — **B1**

(b) Answer: **8 N.**

(c) correct substitution k = 4 / 30 — **M1**

(c) awrt 0.13 N/mm cao — **A1**

(c) Answer: **awrt 0.13 N/mm**

(d) 20 N is beyond the limit of proportionality (found in part b), so extension is no longer directly proportional to force and the elastic constant no longer applies, oe — **B1**

(d) Answer: **20 N is beyond the limit of proportionality, so extension is no longer proportional to force and the elastic constant from part (c) no longer applies.**

Question 5

(a) True cao — **B1**

(a) Answer: **True**

(b) False; non-contact forces also include gravitational and electrostatic forces, which do not need magnetism, oe — **B1**

(b) Answer: **False - non-contact forces also include gravitational and electrostatic forces, not only magnetism.**

(c) True cao — **B1**

(c) Answer: **True**

(d) False; moment is measured in newton-metres (Nm); newtons (N) is the unit of force, oe — **B1**

(d) Answer: **False - moment is measured in newton-metres (Nm), not newtons.**

Question 6

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 — **M1**

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 — **A1**

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 7

use speed = distance / time = 1.8 / 0.9 — **M1**

2.0 m/s cao — **A1**

unit stated as m/s — **B1**

Answer: **2.0 m/s**

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