Unit 11 · Force

HARDER PRACTICE QUESTIONS

Full marks 53

Write your answers on separate paper. Show your working. Take g = 10 m/s^2 where it is needed.

1 Spot the error [3]

Find the mistake in the working and correct it.

A ball of mass 0.2 kg hits a wall at 9 m/s and bounces straight back at 6 m/s. It touches the wall for 0.03 s. Roshni wrote:
"Change in momentum = $0.2 \times (9 - 6) = 0.6$ kg m/s. So the wall's force is $0.6 \div 0.03 =$ **20 N**."

2 Reaching the opposite bank [5]

A boat moves at 5 m/s in still water. A river 120 m wide flows at 3 m/s.

i. The boat is steered straight across. How long does it take to cross, and how far downstream does it land?
ii. What if the river were flowing at 4 m/s instead? Does the crossing take longer? Explain.
iii. The boatman now wants to land exactly opposite his starting point, in the 3 m/s river. Draw the triangle of velocities. How fast does the boat move across, and how long does the crossing take?

3 Three walks [3]

Mingma walks 4 km east, then 6 km north, then 8 km west. Find her resultant displacement, and the distance she has walked. (Add the two walks along one line first.)

4 An elevator goes up and down [5]

An elevator's velocity was read at these times. Upward is positive; between readings the velocity changes uniformly.

Time (s)	0	2	10	12	14	16	26	28
Velocity (m/s)	0	3	3	0	0	−2	−2	0

i. On squared paper, draw its velocity–time graph.
ii. What is it doing between 12 s and 14 s?
iii. Find how far it rises and how far it comes down.
iv. Find its distance traveled, its displacement and its average velocity for the whole trip.
v. Each floor is 3 m high. How many floors is it from its starting floor at the end?

5 Work backwards [4]

An electric bus goes between two stops 1,050 m apart in 120 s. It speeds up uniformly for the first 20 s, moves at a steady top speed, and brakes uniformly for the last 10 s. Sketch its velocity–time graph, and find its top speed, its acceleration, its retardation and its average velocity.

6 Who carries more? [4]

Write your prediction first, then calculate.

Karma and Jeevan carry a 600 N sack hanging from a bamboo pole 2 m long, one end on each shoulder. The sack hangs 0.5 m from Karma's shoulder. Ignore the weight of the pole.

i. Who do you predict feels the larger force?
ii. Take moments about Karma's shoulder to find the force on Jeevan's.
iii. Find the force on Karma's shoulder, and check your answer by taking moments about Jeevan's shoulder.

7 Show that [3]

Two forces of 30 N, equal and opposite, act 0.4 m apart as a couple. Point P lies on the line joining them, 0.1 m **outside** one force. Show that the moment of the couple about P is the same as its moment about the point midway between the forces. What does a single force lack that makes this happen?

8 Is the report possible? [4]

Give a reason from the numbers.

A 2 kg trolley moving at 3 m/s hits a 1 kg trolley at rest on a smooth track. They don't stick together. Three groups report what happened next, each giving the velocities in the first trolley's direction.

Group	2 kg trolley	1 kg trolley
Anju's	1 m/s	5 m/s
Rizwan's	1 m/s	4 m/s
Sneha's	2 m/s	3 m/s

i. Which report or reports cannot be right?
ii. In a fourth run, the 2 kg trolley moved on at 1.5 m/s. What velocity must the 1 kg trolley have had?

9 Rubber or clay? [3]

Write your prediction first, then explain it.

A rubber ball and a lump of clay of the same mass are thrown at a door at the same speed. The ball bounces straight back; the clay sticks. Each is in contact with the door for the same time. Which pushes the door harder? Explain, and say what this tells you about a bounce.

10 How much gas? [3]

A Falcon 9's engines throw gas downward at about 2.8 km/s, and the upward force at lift-off is about 7 million newtons. Force is the momentum given to the gas each second. Estimate the mass of gas thrown out each second. Then say why a fire hose throwing 20 kg of water a second at 15 m/s pushes back on the firefighters' hands, and with what force. (The hose's numbers are made up.)

11 Design a fair test [4]

Yasmin thinks a heavier balloon rocket travels less far along its thread. She has a balloon, a straw, 5 m of thread, tape, a few coins and a measuring tape. Plan a fair test.

i. What will she change, and what will she measure?
ii. Name three things she must keep the same.
iii. How can she make her results more reliable?
iv. What result would support her idea, and why would you expect it from momentum?

12 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Priyanka wrote: "A parked truck has a lot of momentum because it is so heavy. A ball thrown upward has no acceleration at the top, since it has stopped there. And a push of 2 N at 3 m from a pivot has a moment of 6 joules."

13 Which explanation fits the evidence? [3]

Put a compass on a table: the needle swings round to point north, but the compass doesn't slide north. Two students explain it:
Nabin: "The Earth pulls only the needle's north pole, toward the north."
Sujata: "The Earth pulls the north pole northward and the south pole southward, with equal forces."
Which explanation does the evidence support? Explain, and say why the needle stops turning once it points north.

14 Think [4]

A truck of mass 3,000 kg and a car of mass 1,000 kg, each moving at 10 m/s, crash head-on and lock together. The crash lasts 0.1 s.

i. Find the velocity of the wreck.
ii. Find the change in velocity of each vehicle.
iii. Find the average force on each.
iv. Sagar says the truck hits the car with a greater force, which is why the car's passengers suffer more. Is he right?

15 Make your own [2]

Invent a journey in three straight parts that covers exactly 100 m in 20 s, starting and ending at rest, with a top speed other than 10 m/s. Sketch its velocity–time graph and show that the area is 100 m.