National 5
Physics

Dynamics & Space exam questions

these questions have been collated from previous Standard Grade (Credit) and Intermediate 2 exams

Thurso High School

DATA SHEET

Speed of light in materials

Material	*Speed* in m s^{-1}
Air	3.0×10^8
Carbon dioxide	3.0×10^8
Diamond	1.2×10^8
Glass	2.0×10^8
Glycerol	2.1×10^8
Water	2.3×10^8

Gravitational field strengths

	Gravitational field strength on the surface in N kg^{-1}
Earth	9·8
Jupiter	23
Mars	3·7
Mercury	3·7
Moon	1·6
Neptune	11
Saturn	9·0
Sun	270
Uranus	8·7
Venus	8·9

Specific latent heat of fusion of materials

Material	*Specific latent heat of fusion* in J kg^{-1}
Alcohol	0.99×10^5
Aluminium	3.95×10^5
Carbon Dioxide	1.80×10^5
Copper	2.05×10^5
Iron	2.67×10^5
Lead	0.25×10^5
Water	3.34×10^5

Specific latent heat of vaporisation of materials

Material	*Specific latent heat of vaporisation* in J kg^{-1}
Alcohol	11.2×10^5
Carbon Dioxide	3.77×10^5
Glycerol	8.30×10^5
Turpentine	2.90×10^5
Water	22.6×10^5

Speed of sound in materials

Material	*Speed* in m s^{-1}
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Specific heat capacity of materials

Material	*Specific heat capacity* in J kg^{-1} °C^{-1}
Alcohol	2350
Aluminium	902
Copper	386
Glass	500
Ice	2100
Iron	480
Lead	128
Oil	2130
Water	4180

Melting and boiling points of materials

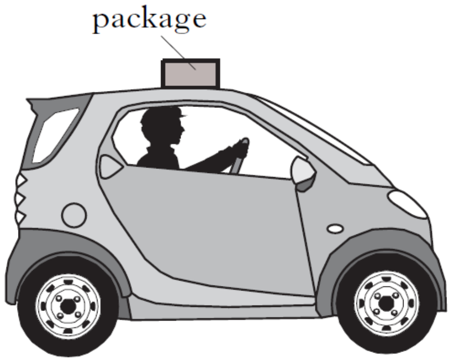
Material	*Melting point* in °C	*Boiling point* in °C
Alcohol	−98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Iron	1537	2737

Radiation weighting factors

Type of radiation	*Radiation weighting factor*
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3

Marks

1. A car driver exits a car park having accidentally left a package resting on the roof of the car. The car is travelling at a constant speed of 15 $m s^{-1}$ when the driver brakes suddenly and the car stops. The package continues to move forward.



(a) (i) On the above diagram sketch the path taken by the package. **1**

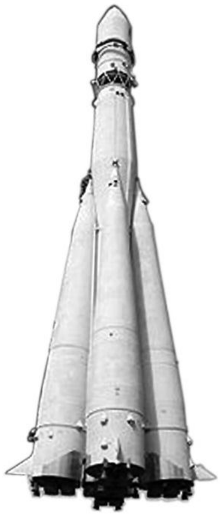
(ii) Explain why the package follows this path. **2**

(b) The package takes 0·55 s to fall to the ground.

Calculate its vertical speed as it reaches the ground. **4**

Marks

2. The first manned space flights took place 50 years ago. Spacecraft were launched into space using powerful rockets.



(a) The operation of a rocket engine can be explained using Newton's Third Law of Motion.

(i) State Newton's Third Law of Motion. **1**

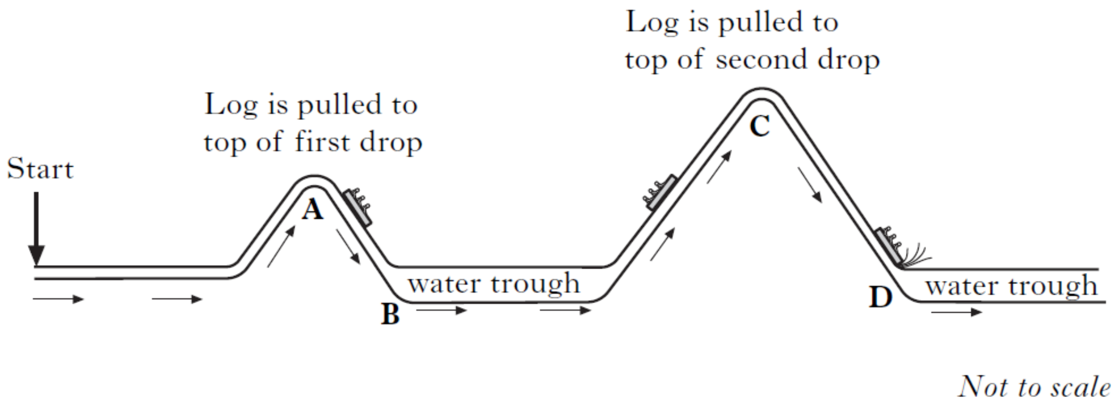
(ii) Explain, in terms of Newton's Third Law, how the rocket engines propel the rocket upwards. **2**

(b) At lift-off, one rocket has a total mass of $2{\cdot}05 \times 10^6$ kg. The resultant force acting upwards on the rocket is $8{\cdot}2 \times 10^6$ N.

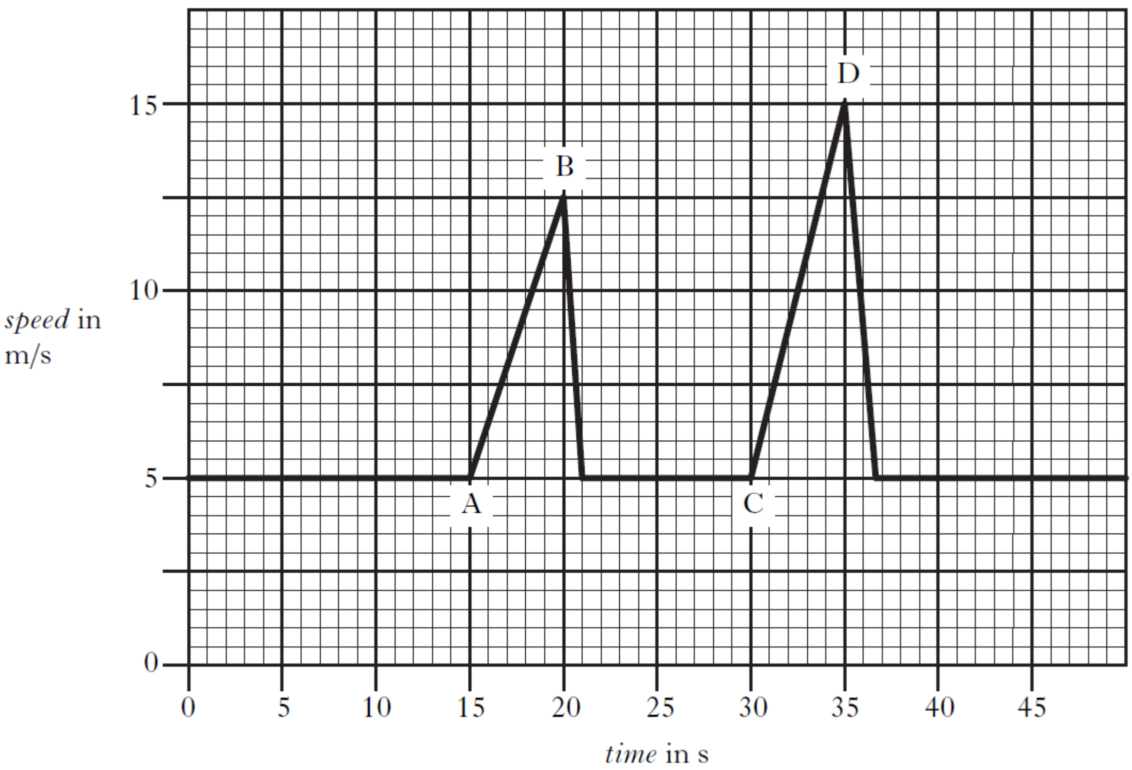
Calculate the acceleration of the rocket at lift-off. **3**

Marks

3. On a visit to a theme park, four students ride the log flume.



The graph shows how the speed of the log varies during the ride.



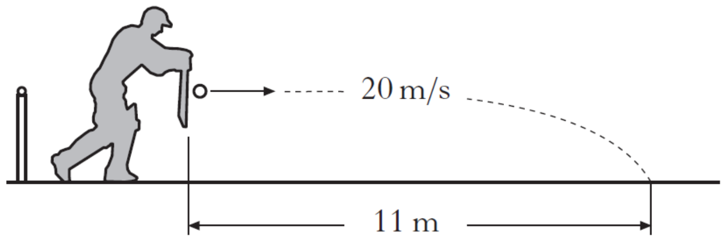
(a) Describe the motion of the log during **AB** on the graph. **1**

(b) Calculate the distance travelled by the log from the start of the ride to the bottom of the first drop. **3**

(c) Calculate the log's acceleration as it goes down the second drop. **3**

Marks

4. A cricketer strikes a ball. The ball leaves the bat horizontally at 20 $m\,s^{-1}$. It hits the ground at a distance of 11 m from the point where it was struck.



Assume that air resistance is negligible.

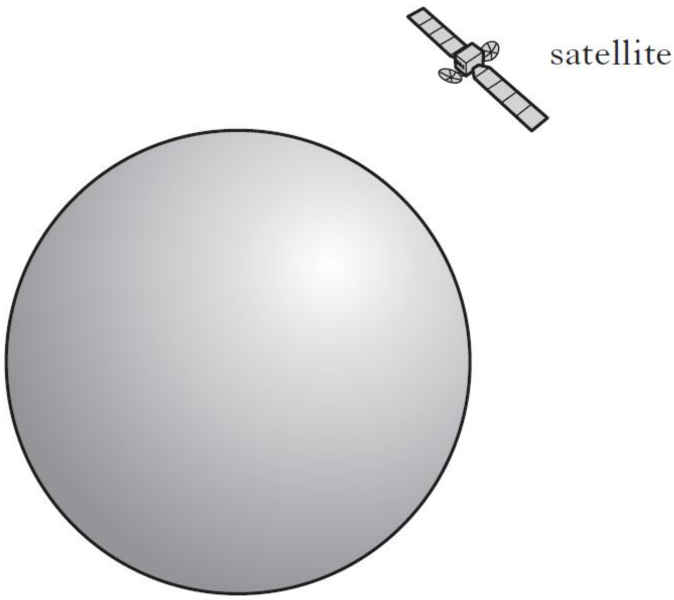
(a) Calculate the time of flight of the ball. **3**

(b) Calculate the vertical speed of the ball as it reaches the ground. **3**

(c) Sketch a graph of vertical speed against time for the ball. Numerical values are required on both axes. **2**

(d) Calculate the vertical distance travelled by the ball during its flight. **3**

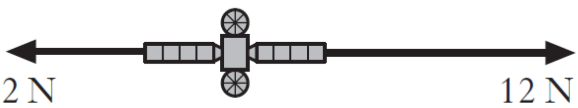
5. A satellite moves in a circular orbit around a planet. The satellite travels at a constant speed whilst accelerating.



(a) (i) Define the term *acceleration*. **1**

(ii) Explain how the satellite can be accelerating when it is travelling at a constant speed. **1**

(b) At one particular point in its orbit the satellite fires two rockets. The forces exerted on the satellite by these rockets are shown on the diagram.



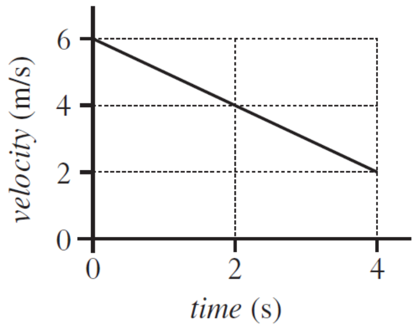
The satellite has a mass of 50 kg. Calculate the resultant acceleration due to these forces. **4**

6. During training an athlete sprints 30 m East and then 40 m West.

Which row shows the distance travelled and the displacement from the starting point?

	Distance travelled	*Displacement*
A	10 m	10 m East
B	10 m	10 m West
C	10 m	70 m East
D	70 m	10 m West
E	70 m	10 m East

7. The graph shows how the velocity of a ball changes with time.



The acceleration of the ball is

A $-8\ \mathrm{m\,s^{-2}}$

B $-1\ \mathrm{m\,s^{-2}}$

C $1\ \mathrm{m\,s^{-2}}$

D $8\ \mathrm{m\,s^{-2}}$

E $24\ \mathrm{m\,s^{-2}}$.

8. An engine applies a force of 2000 N to move a lorry at a constant speed.

The lorry travels 100 m in 16 s.

The power developed by the engine is

A 0·8 W

B 12·5 W

C 320 W

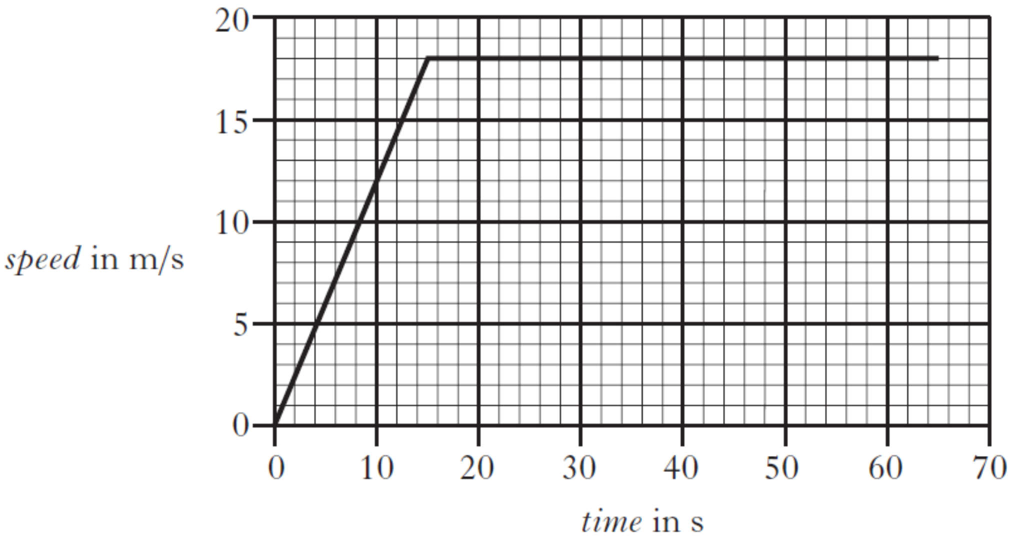
D 12 500 W

E 3 200 000 W.

9. A competitor takes part in a speed cycling event.

The cyclist takes 65 s to complete the race.

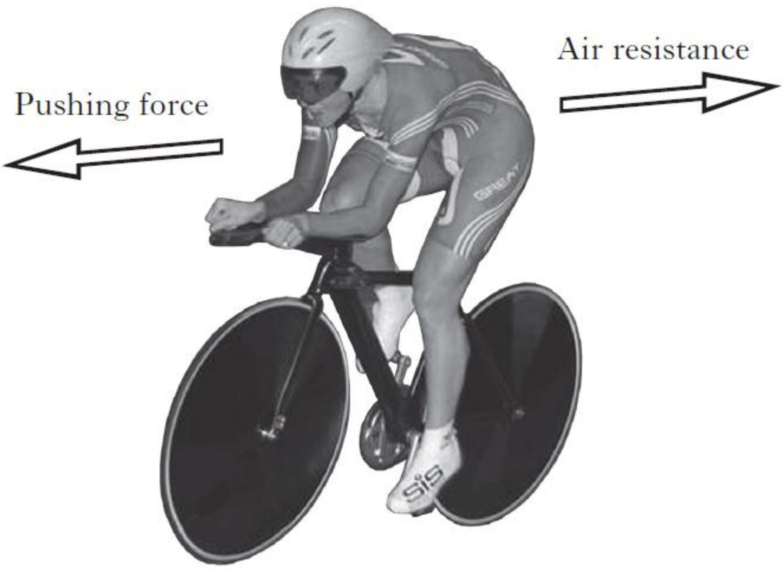
The graph below shows how the cyclist's speed changes with time during the race.



(a) Calculate the acceleration of the cyclist during the first 15 s of the race. **3**

(b) Calculate the distance travelled by the cyclist during the race. **3**

(c) The diagram shows some of the forces acting on the cyclist during the race.

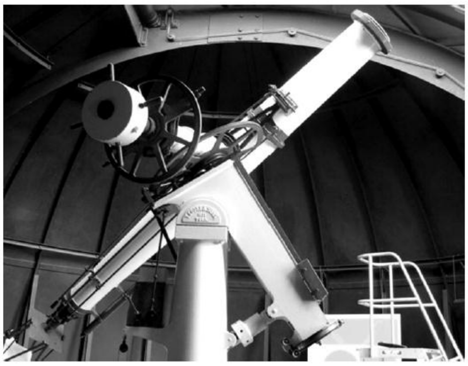


(i) Suggest **one** way in which the cyclist reduces air resistance. **1**

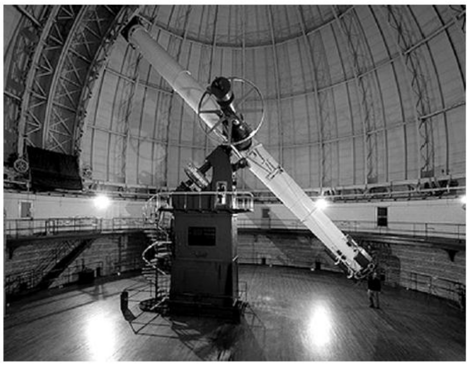
(ii) Suggest **one** place where the cyclist requires friction. **1**

Marks

10. The Mills Observatory in Dundee and the Yerkes Observatory in Wisconsin, USA both have refracting telescopes.



Mills Observatory Telescope



Yerkes Observatory Telescope

Astronomers in both observatories are studying the Andromeda galaxy which is approximately 2·2 million light years away.

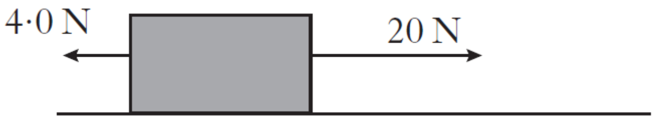
(a) A light year is defined as "*the distance that light travels in one year*".

Show by calculation that 1 light year = $9{\cdot}4608 \times 10^{15}$ m. **3**

(b) Not all telescopes detect visible light.

Why are different kinds of telescope used to detect signals from space? **1**

11. The diagram shows the horizontal forces acting on a box.



The box accelerates at 1·6 $m\,s^{-2}$

The mass of the box is

A 0·10 kg

B 10·0 kg

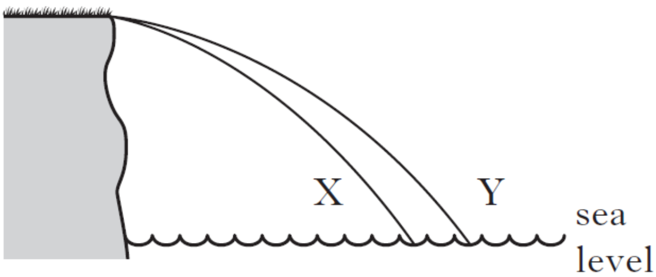
C 15·0 kg

D 25·6 kg

E 38·4 kg.

12. Two identical balls X and Y are projected horizontally from the edge of a cliff.

The path taken by each ball is shown.



A student makes the following statements about the motion of the two balls.

I They take the same time to reach sea level.

II They have the same vertical acceleration.

III They have the same horizontal velocity.

Which of these statements is/are correct?

A I only

B II only

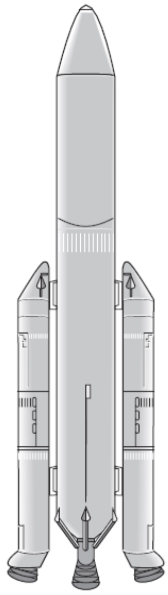
C I and II only

D I and III only

E II and III only

Marks

13. In 2014 the European Space Agency will fly a manned mission to the International Space Station (ISS).



A spacecraft with booster rockets attached will be launched.

(a) On the diagram above draw and label the two forces acting on the spacecraft at lift off. **2**

(b) The combined mass of the spacecraft and booster rockets is $3{\cdot}08 \times 10^5$ kg and the initial thrust on the rocket at lift off is 3352 kN. The frictional forces acting on the rocket at lift off are negligible.

(i) Calculate the weight of the spacecraft and booster rockets at lift off. **3**

(ii) Calculate the acceleration of the spacecraft and booster rockets at lift off. **4**

(c) The ISS orbits at a height of approximately 360 km above the Earth. Explain why the ISS stays in orbit around the Earth. **2**

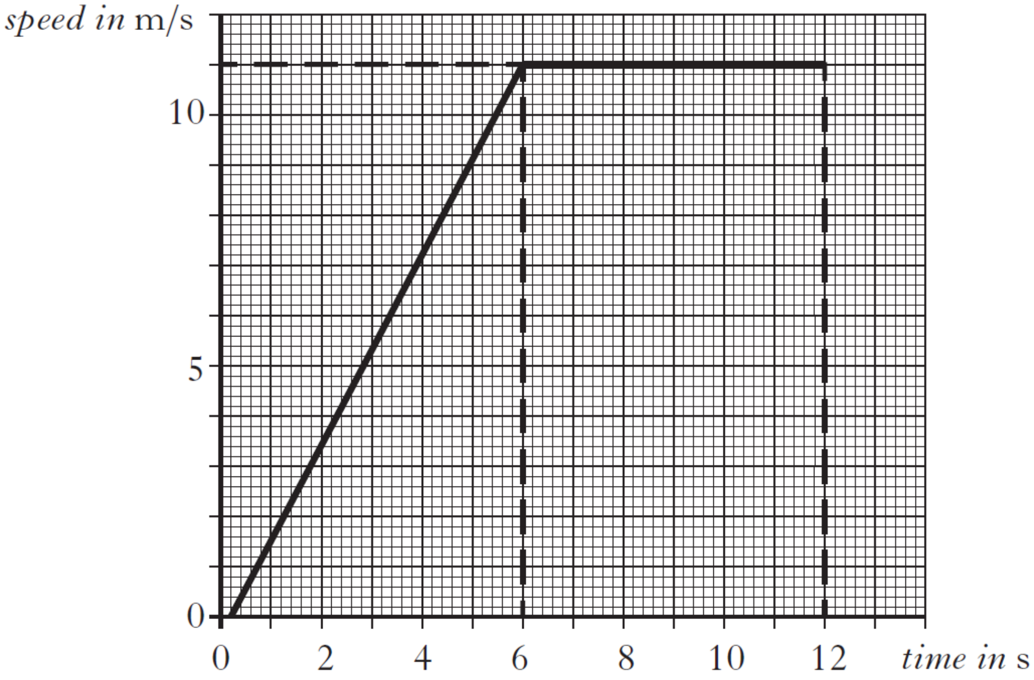
(d) An astronaut on board the ISS takes part in a video link-up with a group of students. The students see the astronaut floating.

(i) Explain why the astronaut appears to float. **1**

(ii) The astronaut then pushes against a wall and moves off.
Explain in terms of Newton's Third Law why the astronaut moves. **1**

Marks

14. The graph shows the motion of a runner during the first 12 s of a race.



(a) Calculate the acceleration of the runner. **3**

(b) Calculate the distance travelled by the runner in the first 12 s. **3**

15. Which row contains two scalar quantities and one vector quantity?

A Distance, displacement, velocity

B Speed, mass, weight

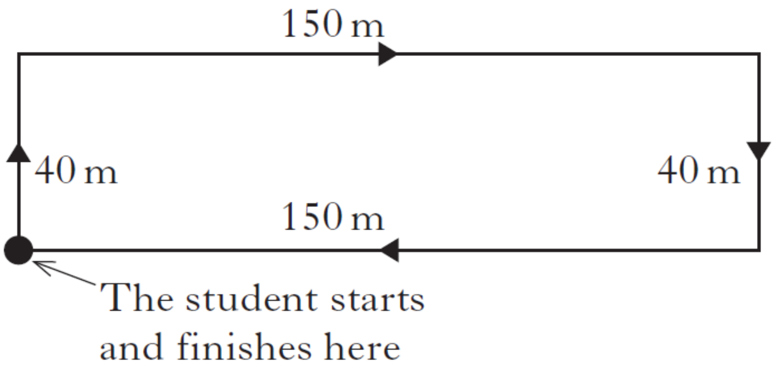
C Distance, weight, force

D Speed, weight, displacement

E Velocity, force, mass

Marks

16. A student follows the route shown in the diagram and arrives back at the starting point.



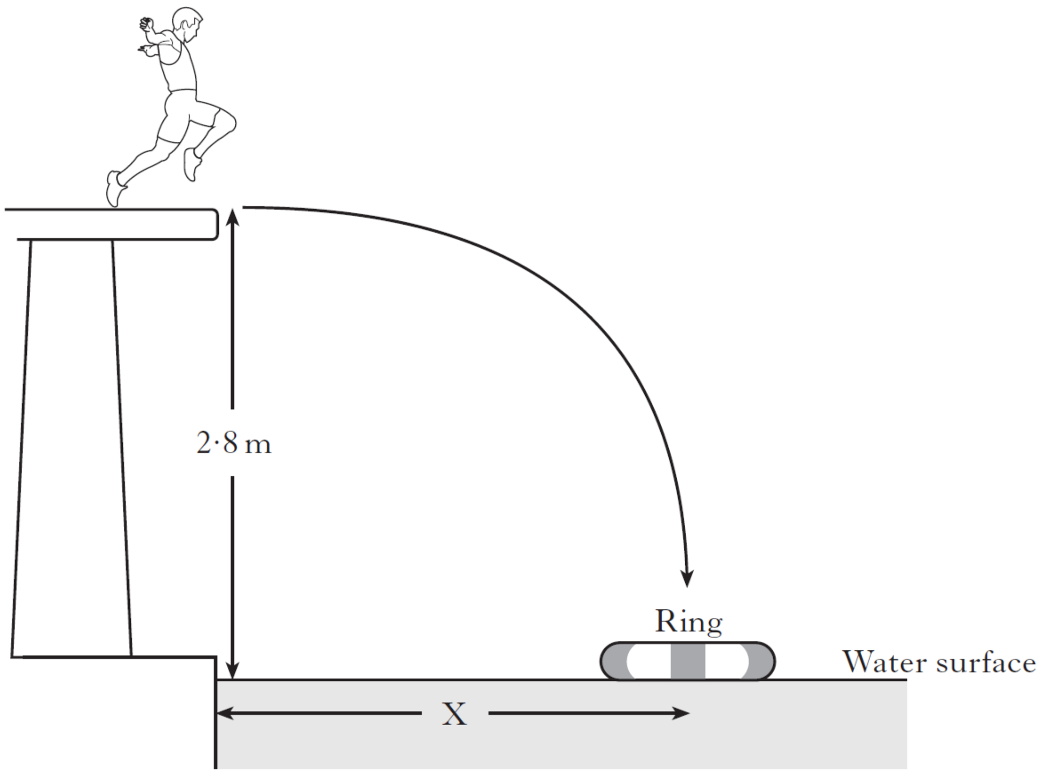
Which row in the table shows the total distance walked and the magnitude of the final displacement?

	Total distance (m)	*Final displacement* (m)
A	0	80
B	0	380
C	190	0
D	380	0
E	380	380

Marks

17. In a TV game show contestants are challenged to run off a horizontal platform and land in a rubber ring floating in a swimming pool.

The platform is 2·8 m above the water surface.



(a) A contestant has a mass of 60 kg.
He runs off the platform with a horizontal velocity of 2 $m\,s^{-1}$. He takes 0·75 s to reach the water surface in the centre of the ring.

(i) Calculate the horizontal distance X from the poolside to the centre of the ring. **3**

(ii) Calculate the vertical velocity of the contestant as he reaches the water surface. **3**

(b) Another contestant has a mass of 80 kg.

Will she need to run faster, slower or at the same horizontal speed as the first contestant to land in the ring?

You **must** explain your answer. **2**

Marks

18. A space probe has a mass of 60 kg.
The weight of the space probe at the surface of a planet in our solar system is 660 N.

The planet is

A Venus

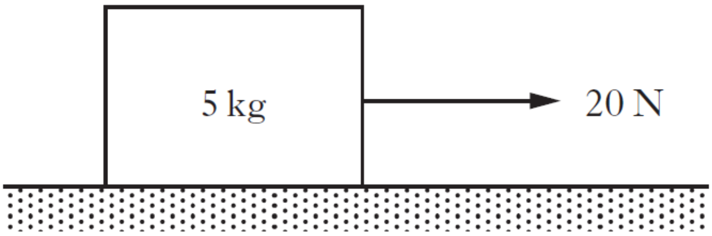
B Mars

C Jupiter

D Saturn

E Neptune.

19. A block is pulled across a horizontal surface as shown.



The mass of the block is 5 kg.

The block is travelling at a constant speed.

The force of friction acting on the block is

A 0 N

B 4 N

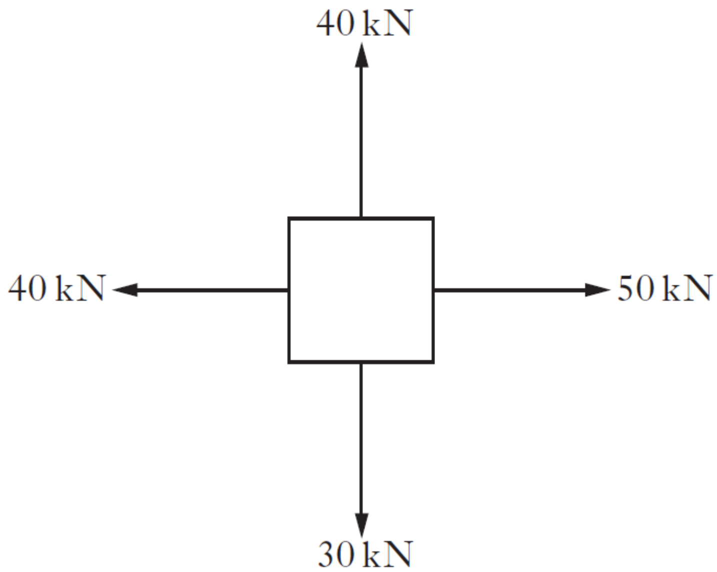
C 15 N

D 20 N

E 25 N.

Marks

20. Four tugs apply forces to an oil-rig in the directions shown.



Which of the following could represent the direction of the resultant force?

A 

B 

C 

D 

E