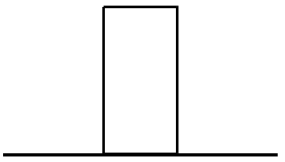
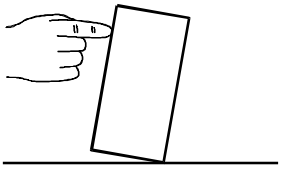
1. A child stands a wooden brick on its end as shown in the diagram.



The child then pushes the brick to make it tilt.



How far must the brick be tilted to make it fall over?

Explain your answer.

(You may draw a labelled diagram if you wish.)

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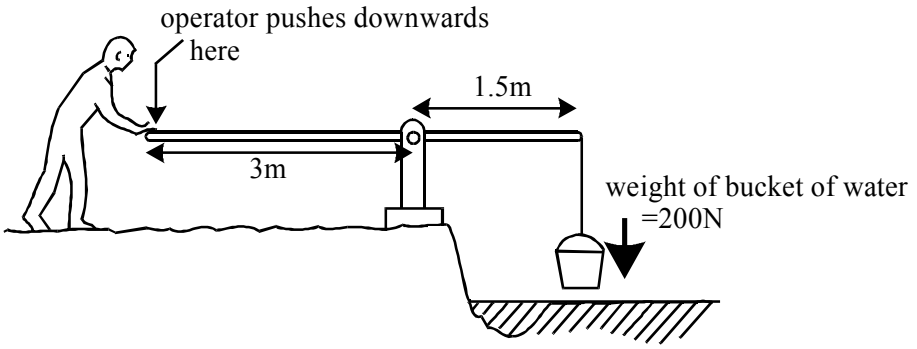
(Total 2 marks)

2. The diagram shows a simple machine for lifting water from a river.



(a) Calculate the turning force (moment) of the bucket of water.

(Show your working.)

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Answer ..... Nm (newton metre)

(2)

(b) What can you say about the size of downwards force the operator must use to balance the moment of the bucket of water?

(Explain your answer, using numbers if you can.)

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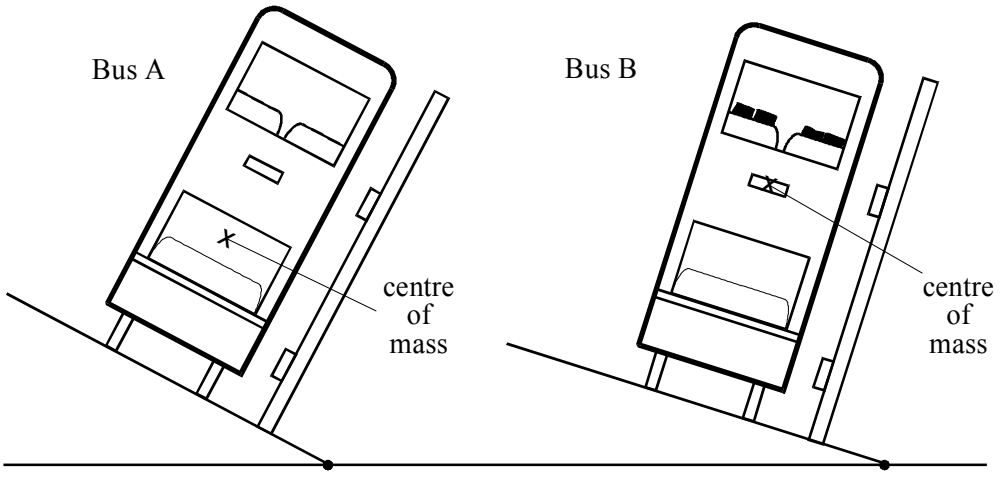
(4)
(Total 6 marks)

3. The diagram shows two buses. Bus A is empty. Bus B contains bags of sand upstairs to represent passengers.

Each bus has been tilted as far as it can without falling over.



(a) Each bus will topple over if it is tilted any further.

Explain, in as much detail as you can, why this will happen.

(You can draw on one of the diagrams as part of your answer if you want to.)

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(2)

(b) What difference does it make to the stability of the bus when the upper deck is full of "passengers"? Explain your answer as fully as you can.

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(3)

(c) Why are the bags of sand in bus B only put upstairs?

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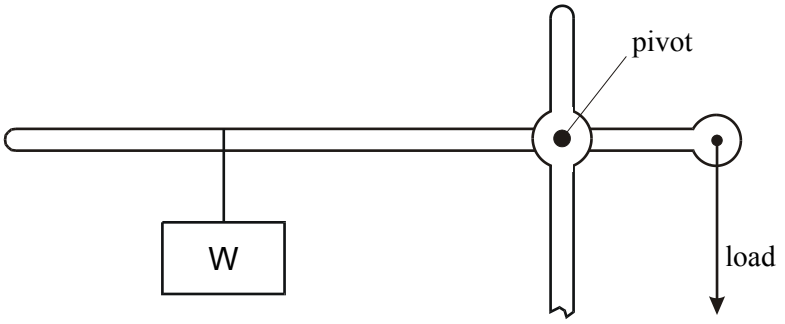
(1)
(Total 6 marks)

4. The diagram below shows an outline of a balance. The balance is used to weigh lorries. A fraction of the weight of a lorry is used as the load on the right side of the pivot.

A standard weight W is moved along the arm until the weight of the load is balanced.



(a) As the weight W is moved away from the pivot it can support a heavier load.
Why is this?

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.....

(2)

(b) (i) The weight W is 100 N. When it is 0.2 m from the pivot it balances the load. Calculate the moment of the weight W about the pivot.

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Answer ..... Nm

(2)

(ii) The load is one hundredth of the weight of the lorry and is 0.02 m from the pivot. Calculate the weight of the lorry.

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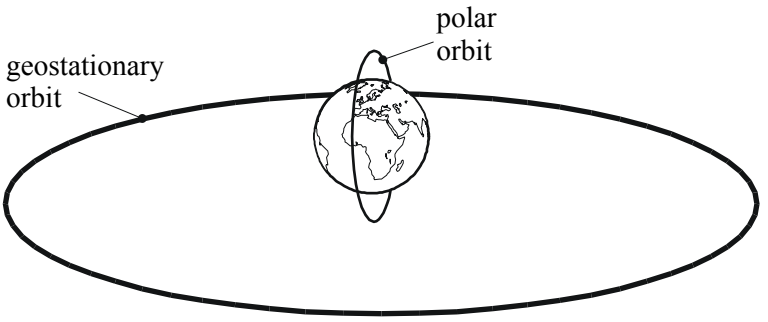
Answer ..... N

(2)

(Total 6 marks)

5. The diagram below shows the orbits for two types of satellite, a polar orbit and a geostationary orbit.



(a) A satellite in stable Earth orbit moves at a constant speed in a circular orbit because there is a single force acting on it.

(i) What is the direction of this force?

.....

(1)

(ii) What is the cause of this force?

.....

(1)

(iii) What is the effect of this force on the **velocity** of the satellite?

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(1)

(iv) In which of the orbits shown above would this force be bigger?
Explain the reason for your answer.

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(2)

(v) Explain why the kinetic energy of the satellite remains constant.

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(2)

(b) A satellite in a geostationary orbit takes about 24 hours to complete one orbit, whilst one in a low polar orbit typically takes 90 minutes.

(i) Suggest, with reasons, one use of a satellite in a geostationary orbit.

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(2)

(ii) Suggest, with reasons, one use of a satellite in a polar orbit.

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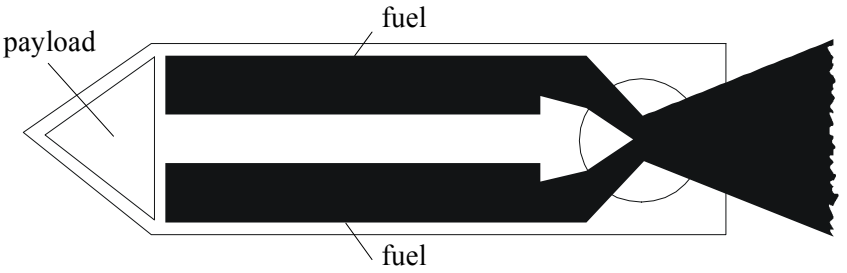
(2)

(c) Sometimes the motion of a rocket in space has to be changed. The diagram below shows such a rocket being accelerated.



Use your ideas of momentum to explain why the rocket accelerates.

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(4)
(Total 15 marks)

6. The table shows part of the flight plan for one of the manned Apollo flights to the Moon.

TIME (hours/minutes)	FORCES AND VELOCITIES
00 00	Lift off.
00 11	Vehicle in Earth orbit. Height 160 km. Speed 28 000 km/h. Rocket motor shut off.
01 35	Ignite rocket motor to achieve escape velocity.
01 40	Achieve escape velocity – 40 000 km/h.
01 41	Rocket motor shut off. Vehicle on way to Moon.
18 40	Speed has fallen to 8 700 km/h.
63 16	Turn vehicle so that rocket motor faces Moon. Ignite rocket motor.
63 23	Shut down motor. Vehicle has slowed to 3 700 km/h and is in orbit 130 km above the surface of the Moon.

(a) Between 00 11 and 01 35 hours the vehicle was in Earth orbit.

Explain as fully as you can why the vehicle was able to remain in orbit.

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(4)

(b) Explain why the speed of the space vehicle fell from 40 000 km/h at 01 40 hours to 8 700 km/h at 18 40 hours.

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(3)

(c) Explain what would have happened to the speed of the vehicle if the motor had not been ignited at 63 16 hours.

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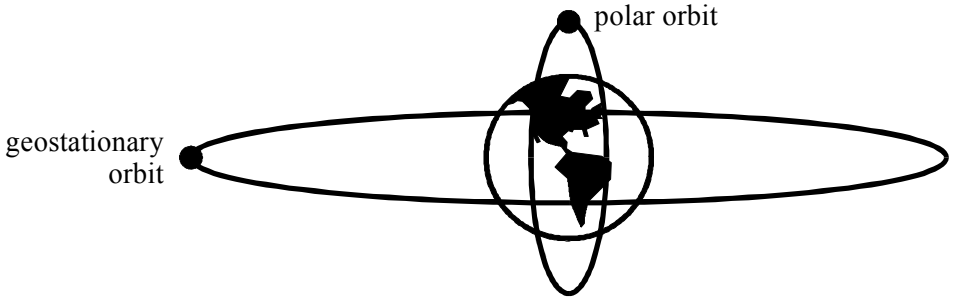
(2)
(Total 9 marks)

7. The diagram shows circular orbits for two satellites around the Earth.



(a) (i) How long does it take a geostationary satellite to complete one orbit?

……

(1)

(ii) How is the orbital time of the polar satellite shown in the diagram different to that of the geostationary one?
Explain your answer.

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(2)

(b) Suggest one use of a satellite in:

(i) geostationary orbit; .....

……

(ii) polar orbit. .....

……

(2)

(c) The Hubble Telescope is in orbit round the Earth.
What is the advantage of this telescope over ground-based telescopes on Earth?

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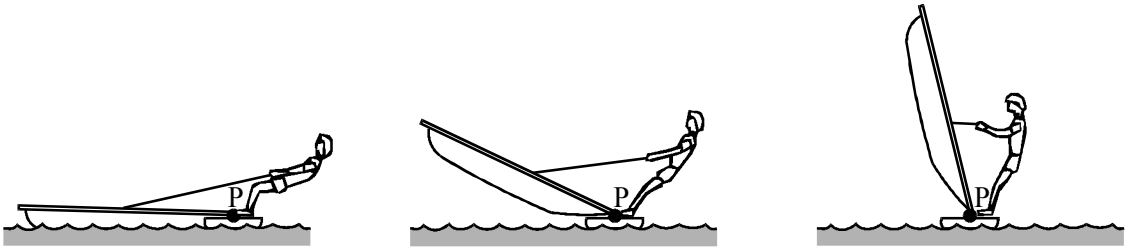
(1)
(Total 6 marks)

8. (a) The diagrams show a windsurfer pulling up the sail of a sailboard. The mast pivots at point P.



A **B** **C**

In which position, **A**, **B** or **C** must the windsurfer pull with the largest force? Give a reason for your answer.

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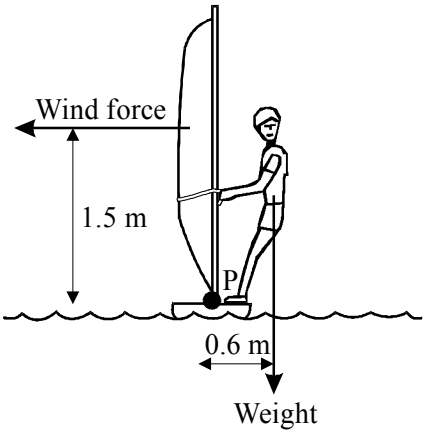
(2)

(b) Once the mast is upright, the windsurfer and the sailboard are *in equilibrium.*



(i) What does *in equilibrium* mean?

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(1)

(ii) The weight of the windsurfer is 700 newtons. Use the equation below to calculate the moment exerted by the windsurfer on the sailboard. Show clearly how you work out your answer.

moment = force × perpendicular distance from pivot

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.....

Moment = ... Nm

(2)

(iii) Use the relationship below to calculate the horizontal force of the wind on the sail. Show clearly how you work out your answer.

total clockwise moment = total anticlockwise moment

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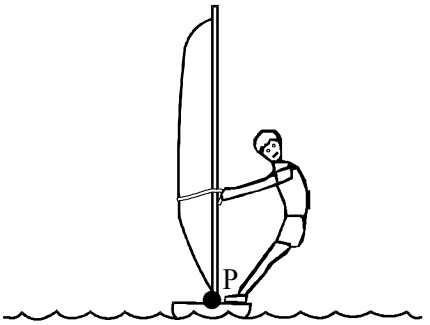
Force = ... N

(2)

(c) As the wind speed increases the windsurfer leans further out from the sailboard.



This position allows the windsurfer and sailboard to stay in equilibrium. Explain why.

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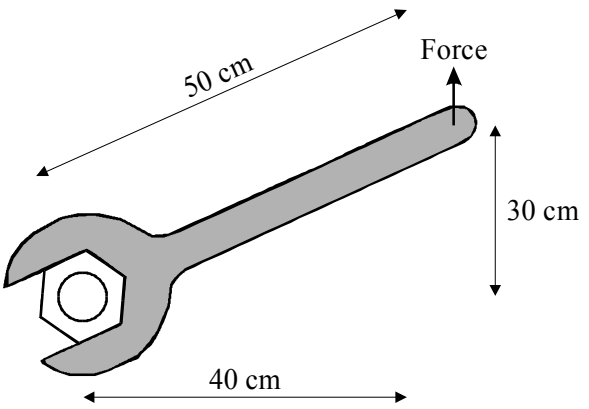
(3)
(Total 10 marks)

9. The diagram shows a spanner being used to undo a tight nut.



The nut was tightened using a moment of 120 newton metres.

Use the following equation to calculate the force needed to undo the nut. Show clearly how you work out your answer.

moment = force × perpendicular distance from pivot

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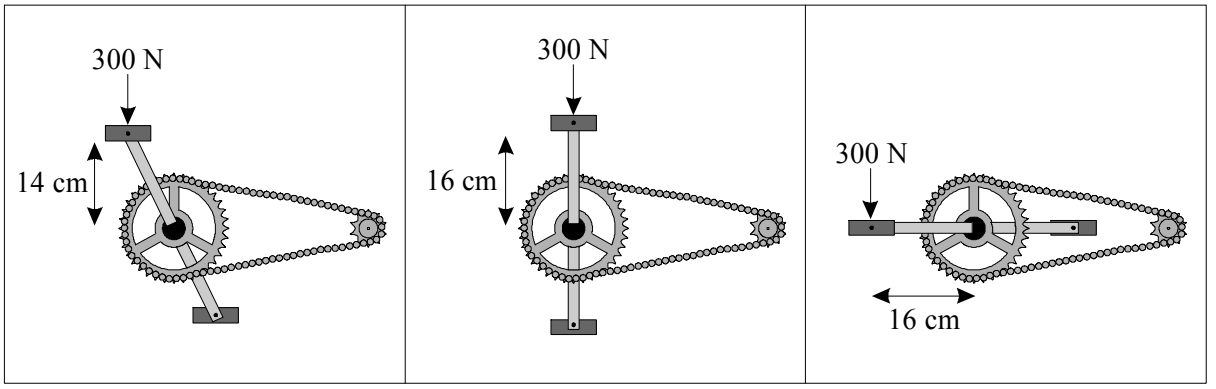
Force = ... N

(Total 2 marks)

10. For part of the ride the cyclist pushed on the pedals with a constant vertical force of 300 N. The simplified diagrams show the pedals in three different positions.



A **B** **C**

(i) Which position, **A**, **B**, or **C**, gives the largest moment on the pedal?

.....

(1)

(ii) Use the following equation to calculate, in Newton metres, the size of the largest moment on the pedal.

moment = force × perpendicular distance from pivot

.....

.....

Moment = ... Nm

(2)

(Total 3 marks)