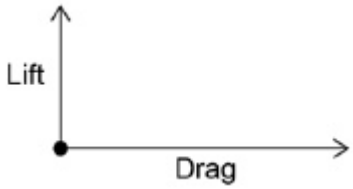
1 (a) **Figure 1** shows an aircraft flying at a constant velocity and at a constant height above the ground.

Figure 1

Complete the free body diagram in **Figure 2** to show the other two forces acting on the aircraft.

Figure 2



(2)

(b) A small aircraft accelerated down a runway at 4.0 m/s^2

The aircraft started from rest and reached a speed of 34 m/s just before take-off.

Calculate the distance the aircraft travelled while accelerating.

Give your answer to 2 significant figures.

_____

_____

_____

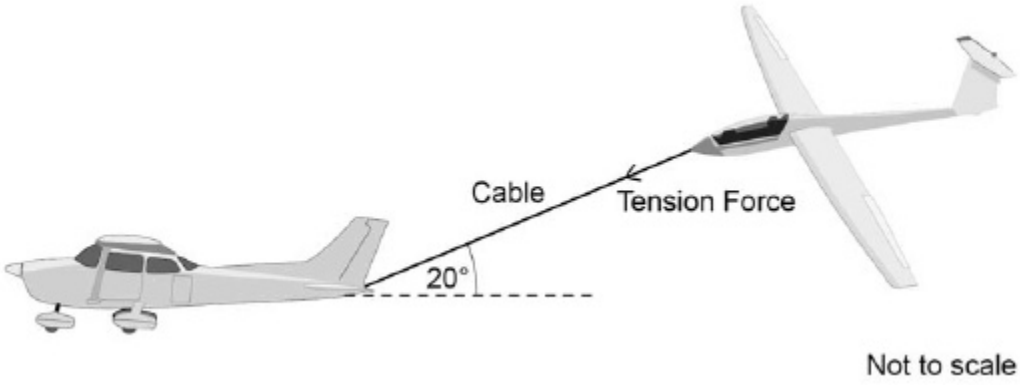
_____

Distance = _____ m

(4)

(c) **Figure 3** shows the small aircraft being used to tow a glider.

Figure 3



The tension force in the cable can be resolved into a horizontal component and a vertical component.

The tension in the cable is 2000 N

The cable makes an angle of 20° with the horizontal.

Draw a vector diagram to determine the magnitude of the two components of the tension force in the cable.

Magnitude of the horizontal component = _____ N

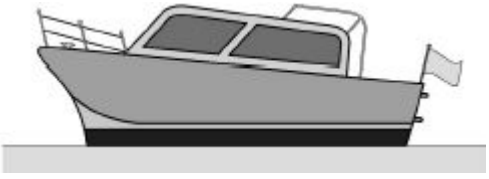
Magnitude of the vertical component = _____ N

(1)

(Total 10 marks)

2 **Figure 1** shows a boat floating on the sea. The boat is stationary.

Figure 1



(a) **Figure 2** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

Figure 2

(2)

(b) Calculate the mass of the boat.

Use the information given in **Figure 2**.

gravitational field strength = 9.8 N/kg

Give your answer to **two** significant figures.

_____

_____

_____

_____

Mass = _____ kg

(4)

(c) When the boat propeller pushes water backwards, the boat moves forwards.
The force on the water causes an equal and opposite force to act on the boat.

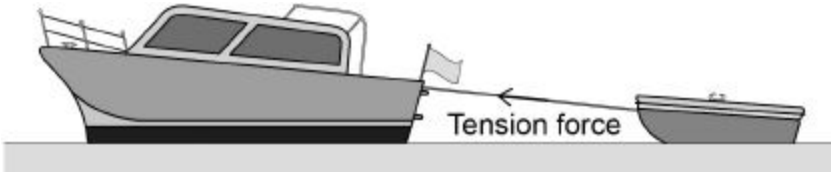
Which law is this an example of?

_____

(1)

(d) **Figure 3** shows the boat towing a small dinghy.

Figure 3



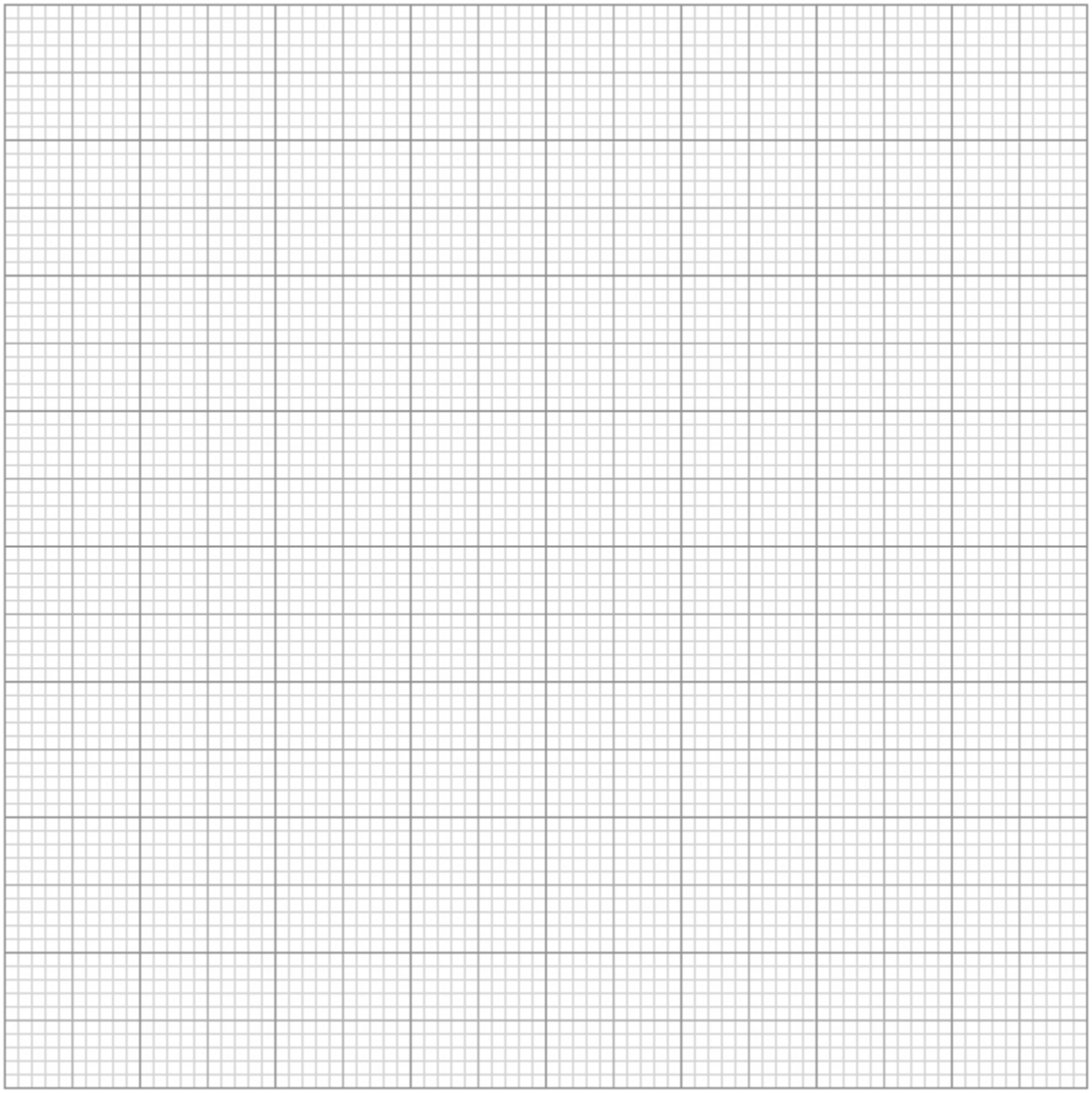
The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

horizontal force forwards = 150 N
vertical force upwards = 50 N

Figure 4 shows a grid.

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

Figure 4



Magnitude of the tension force in the tow rope = _____ N

Direction of the force on the dinghy caused by the tension force in the tow rope = _____

(4)

(Total 11 marks)

Mark schemes

1

(a) arrow vertically down – same size as lift – labelled weight

judge by eye

1

arrow to the left – same size as drag - labelled thrust

judge by eye

*two correct arrows without labels gains **1** mark*

1

(b) $34^2 - (0^2) = 2 \times 4.0 \times s$

1

$$\frac{34 \times 34}{8} = s$$

1

s = 144.5

1

s = 140 (2 sig figs)

*an answer of 140 scores **4** marks*

*an answer of 144.5 scores **3** marks*

1

(c) tension force drawn to a suitable scale and in correct direction

1

triangle completed showing correct components

1

scale used to determine both component forces

1

horizontal component = 1900 N
vertical component = 680 N

allow 1850 to 1925 inclusive

allow 660 to 700 inclusive

1

[10]

2

(a) arrow of equal size pointing vertically upwards

judged by eye

ignore horizontal arrows if equal and opposite

horizontal arrows of unequal length negates this mark

1

labelled 'upthrust'

ignore buoyancy

ignore 25 kN

1

(b) weight = 25 kN

allow 24 to 25 kN inclusive

1

25 000 = mass × 9.8

or

$$m = \frac{25000}{9.8}$$

allow their W correctly converted and substituted

1

m = 2551 kg

allow correctly calculated value using their converted W
allow a value correctly calculated with W in kN

1

m = 2600 kg

allow a calculated answer correctly rounded to 2 significant figures

1

*an answer of 2600 scores **4** marks*

(c) Newton's 3rd law (of motion)

1

(d) vertical force (50 N) drawn

and

horizontal force (150 N) drawn to the same scale

1

resultant tension force in the correct direction

shown by an arrowhead

1

value of the tension force in the range 156 N−160 N

allow a calculated value of 158

1

value of direction in the range 18°−20° (from the horizontal)

allow 70° to 72° (from the vertical)
allow a bearing in the range 288 to 290

1

[11]